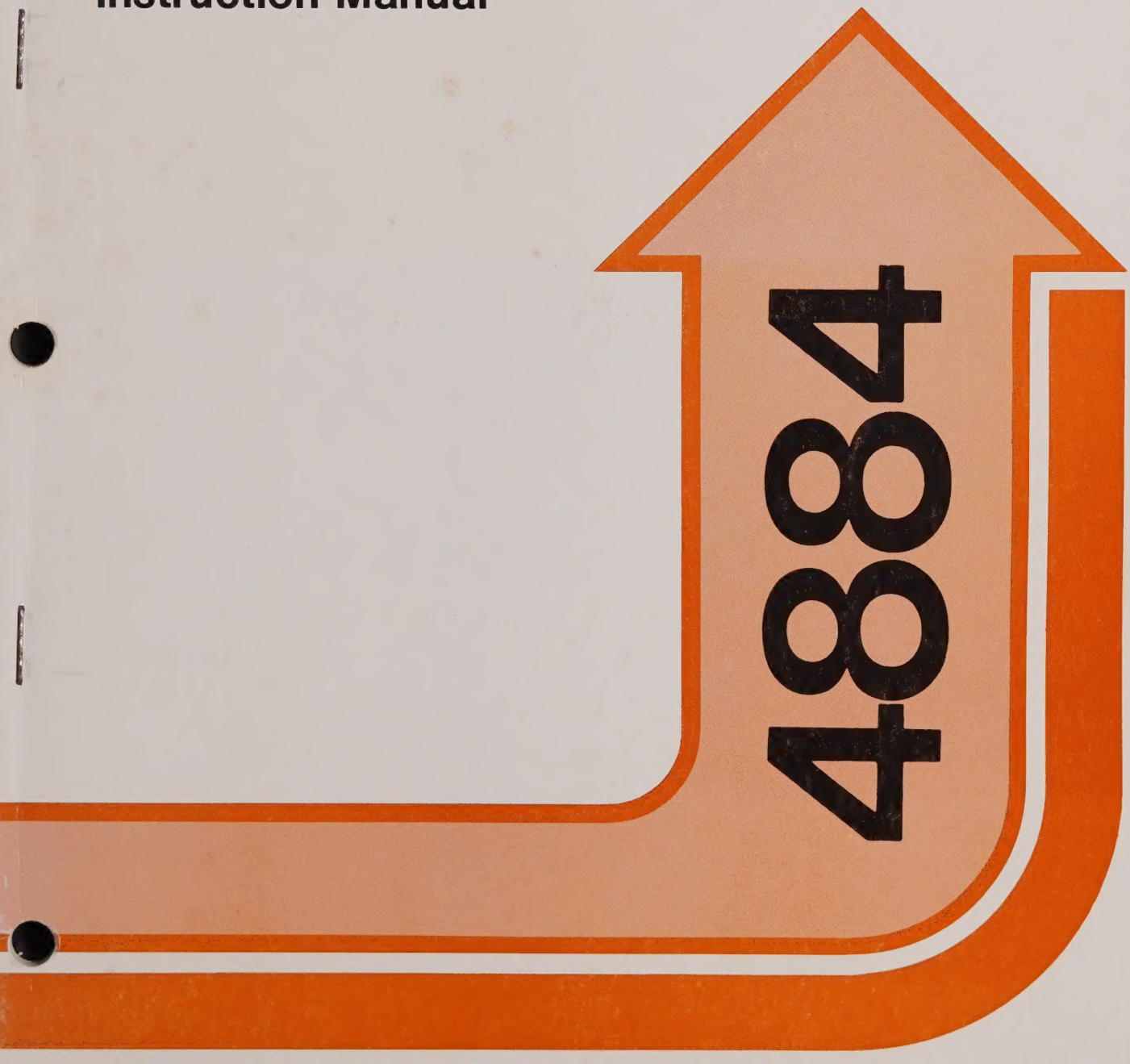
ICS ELECTRONICS CORPORATION

MODEL 4884
RS232 to IEEE 488 COUPLER
Instruction Manual



CONSTRUCTION

Model 4884
RS232 to IEEE488 Coupler
Instruction Manual

ICS ELECTRONICS CORPORATION

2185 Old Oakland Road, San Jose, CA 95131
Phone (408) 263-4844, TWX 910 338 7810

Publication Number 120001 Rev. 4
May 1983 Edition

© *1979 ICS ELectronics Corporation, 1980*

LIMITED WARRANTY

Within 12 months of delivery, ICS Electronics Corporation will repair or replace, at our option, this ICS product if any part is found to be defective in materials or workmanship. Labor is included. Return this product to ICS Electronics or other designated repair station, freight prepaid, for prompt repair or replacement. Contact ICS for a return material authorization prior to returning the product for repair.

CERTIFICATION

ICS Electronics Corporation certifies that this instrument was carefully inspected and tested at the factory prior to shipment and was found to meet all requirements of the specification under which it was furnished.

Contents

1 **SPECIFICATIONS** 1-1

1.1 DESCRIPTION 1-1

1.1.1 4884 Coupler 1-1
1.1.2 IEEE 488 BUS 1-1

1.2 DETAIL SPECIFICATIONS 1-4

1.2.1 Model Number Designation 1-4
1.2.2 IEEE 488 Bus Interface Functions 1-5
1.2.3 IEEE 488 Bus Specifications 1-5
1.2.4 Talker Format 1-5
1.2.5 Listener Format 1-5
1.2.6 Special 488 Functions 1-6
1.2.7 Data Storage 1-6
1.2.8 Serial I/O 1-7
1.2.9 Physical Description. 1-8

2 **INSTALLATION** 2-1

2.1 UNPACKING AND INSPECTION 2-1
2.2 BENCH OPERATION 2-1
2.3 RACK INSTALLATION 2-1
2.4 POWER CONNECTIONS 2-2
2.5 IEEE 488 BUS CONNECTIONS 2-2
2.6 SERIAL RS-232 (20 mA) CONNECTIONS 2-3

2.6.1 Connection to a Computer's RS-232 Port . . . 2-5
2.6.2 Connection to a Modem 2-5
2.6.3 Connection to a Terminal 2-5
2.6.4 Connection to a Computer's 20mA Port . . . 2-5
2.6.5 Connection to a Teletype or a 20mA Terminal. 2-6

CONTENTS

3 OPERATION 3-1

3.1 CONTROLS 3-1

3.1.1 Front Panel Controls 3-1
3.1.2 Address Switch 3-1
3.1.3 115/230 Switch 3-2
3.1.4 Baud Rate Switch Assembly 3-3
3.1.5 Data Character Format Switch 3-4

3.2 OPERATING INSTRUCTIONS. 3-6

3.2.1 Pre-Operation Setup. 3-6
3.2.2 Operation 3-6

3.3 USER PROGRAM AIDS 3-7

3.3.1 Tektronix 4051 Programs. 3-7
3.3.2 Hewlett-Packard 9825 Calculator Programs . 3-11
3.3.3 Commodore PET Programs 3-15
3.3.4 Fluke 1720A Programs. 3-16

3.4 INTERNAL PROGRAM CHANGES 3-18

3.4.1 4880 PROM Alteration Instructions 3-18

3.4.2 PROM Program Tables. 3-20

3.5 PWB CHANGES. 3-21

3.5.1 Parallel Poll Enable 3-21

4 THEORY OF OPERATION 4-1

4.1 BLOCK DIAGRAM DESCRIPTION. 4-1

4.1.1 Simplified Block Diagram 4-1
4.1.2 Detailed Block Diagram 4-1

4.2 DETAILED LOGIC DESCRIPTION. 4-3

4.2.1 Main Board. 4-3
4.2.2. Serial I/O Card 4-5

CONTENTS

5 MAINTENANCE 5-1

5.1 INTRODUCTION 5-1
5.2 REFERENCE DESIGNATIONS 5-1
5.3 TROUBLESHOOTING PROCEDURES 5-1
5.4 LOGIC CONVENTIONS 5-6

6 PARTS LIST AND LOCATION 6-1

6.1 INTRODUCTION 6-1
6.2 REPLACEMENT PARTS 6-1

6.2.1 Standard Parts 6-1
6.2.2 Special Parts 6-1
6.2.3 Parts Ordering Information 6-1

6.3 PARTS LIST 6-5

7 DRAWINGS, DIAGRAMS, WIRE LISTS 7-1

TABLES

1-1	IEEE 488 COMMAND AND ADDRESS MESSAGES	1-10
2-1	488 BUS CONNECTIONS (J1)	2-2
2-2	J2 SERIAL I/O PIN ASSIGNMENTS	2-4
3-1	BAUD RATE SWITCH SETTINGS	3-3
3-2	DATA CHARACTER FORMAT SWITCH SETTINGS	3-4
3-3	SECONDARY ADDRESS	3-20
3-4	EOM CHARACTER	3-20
5-1	MODEL 4884 FAULT ISOLATION STEPS	5-3
6-1	LIST OF MANUFACTURERS BY ABBREVIATIONS	6-2
6-2	4884/5A RECOMMENDED SPARE PARTS LIST	6-6
6-3	4884 RS-232 COUPLER - PARTS LIST	6-9
6-4	4884 MAIN BOARD - PARTS LIST	6-11
6-5	PC BOARD ASSEMBLY - PARTS LIST	6-11
6-6	4884 SERIAL I/O CARD - PARTS LIST	6-15
6-7	4880 MEMORY EXPANSION MODULE - PARTS LIST	6-16

FIGURES

1-1	Model 4884 RS-232 to IEEE 488 Bus Controller	1-2
1-2	IEEE 488 BUS	1-4
1-3	4884 Outline Dimensions	1-9
2-1	4884 Modem Cable Assembly	2-6
2-2	4884 Terminal Cable Assembly	2-7
2-3	4884 TTY Cable Assembly	2-8
3-1	4884 Rear Panel	3-2
3-2	Data Character Switch Location	3-5
3-3	4051 Display for Sequential 0 thru 9 Ten Digit Input	3-8
3-4	HP Address Check Programs	3-12
3-5	HP Basic Read/Write Program	3-13
3-6	HP SRQ Interrupt Program	3-14
3-7	PET Input Program	3-16
3-8	Fluke Address Test Program	3-17
3-9	Fluke SRQ Loop Program	3-17
3-10	4884 Main Board Component Locations	3-19
4-1	4884 Block Diagram	4-2
4-2	4884 Detailed Block Diagram	4-4
5-1	Standard Logic Symbols	5-7
6-1	4884 Controller Exploded Assembly	6-8
6-2	Assembly, 4884 Main Board	6-10
6-3	Assembly, 4884 RS-232 I/O Card	6-14
6-4	Assembly, Memory Expansion Module	6-14
7-1	Model 4884 Main Board Logic Diagram	7-3/8
7-2	Model 4880 Memory Expansion Module Logic Diagram	7-9/10
7-3	Model 4884 Serial I/O Card Logic Diagram	7-11/12

1

Specifications

1.1 DESCRIPTION

1.1.1 4884 Coupler

The ICS Model 4884 RS-232 to IEEE 488 Coupler is a general purpose interface used to connect devices with serial RS-232 interfaces to the IEEE 488 Instrument Bus. The 4884 Coupler acts as a Talker interface for serial transmitting devices such as keyboards, and as a Listener for serial output devices such as printers. The 4884's serial I/O connector provides a full set of RS-232 signals to interface to a modem and a second set of RS-232 signals for a terminal. In addition, the 4884 also provides a parallel set of 20mA current loop drivers and receivers for interfacing to a minicomputer or to a terminal.

The 488's Bus Connector is compatible with the electrical and physical requirements of IEEE Specification 488-1978. The 488 Bus uses eight lines for data and eight lines for control and handshake functions. All data is transferred as parallel eight bit characters under the direction of a controlling device. The 488 Bus concept allows many different instruments to be quickly connected together to form a working system without the use of multiple, special purpose interfaces.

1.1.2 IEEE 488 BUS

The IEEE 488 Bus transfers data and commands between the components of an instrumentation system on 16 signal lines as shown in Figure 1-2. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel to the signal lines.

Eight of the lines (D101-D108) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, co-ordinated by the three handshake lines (DAV, NRFD, NDAC). The other five lines are for control of Bus activity.

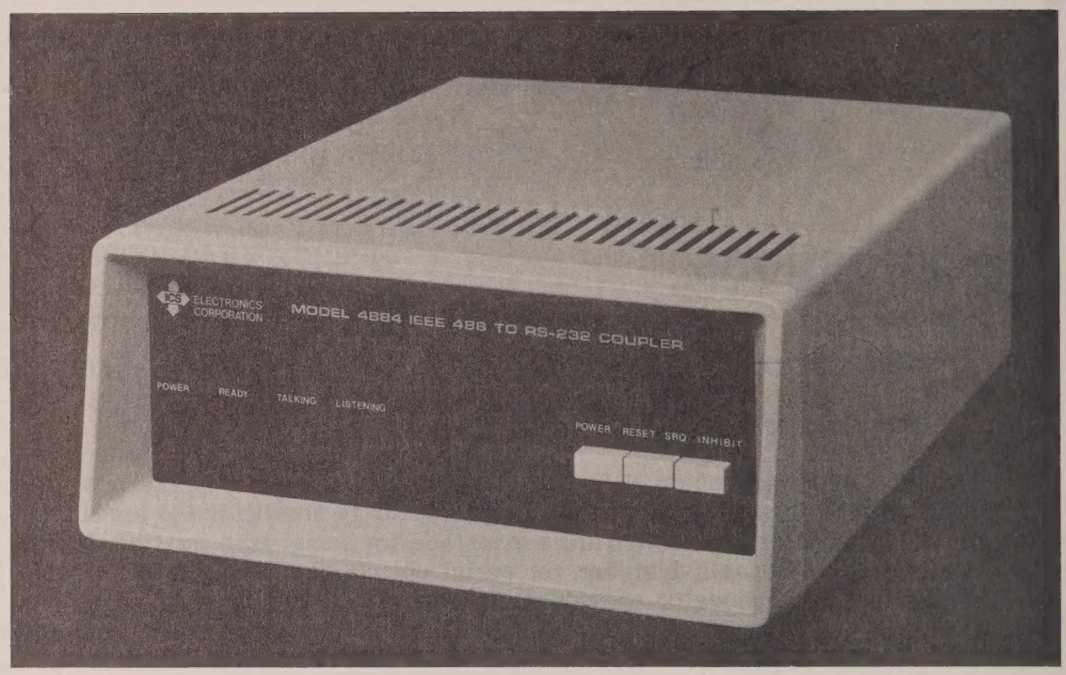


Figure 1-1 Model 4884 RS-232 to IEEE 488 Bus Controller

Devices connected to the Bus may be talkers, listeners, or controllers. The controller dictates the role of each of the other devices by setting the ATN (attention) line true and sending talk or listen addresses on the data lines (D101-D108). Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a PC board. While the ATN line is true, all devices must listen to the data lines. When the ATN line is false, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

Several listeners can be active simultaneouly but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers will be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

The ATN line is one of the five control lines. When ATN is true, addresses and universal commands are transmitted on only seven of the data lines using the ASCII[1] code. The Bus address and command codes are shown in the MSG column of Table 1-1. When ATN is false, any data code of 8 bits or less understood by both talker and listener(s) may be used. The data codes are typically ASCII characters shown in the ASCII columns of Table 1-1.

The other control lines are IFC, REN, SRQ, EOI.

IFC (interface clear) places the interface system in a known quiescent state.

REN (remote enable) is used with other coded messages to select either local or remote control of each device.

Any active device can set the SRQ (service request) line true. This indicates to the controller that some device on the Bus wants attention, such as a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

EOI (end or identify) is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines true, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

In the interest of cost-effectiveness it is not necessary for every device to be capable of responding to all the lines. Each can be designed to respond only to those lines that are pertinent to its function on the Bus.

---

[1] American Standard Code for Information Interchange

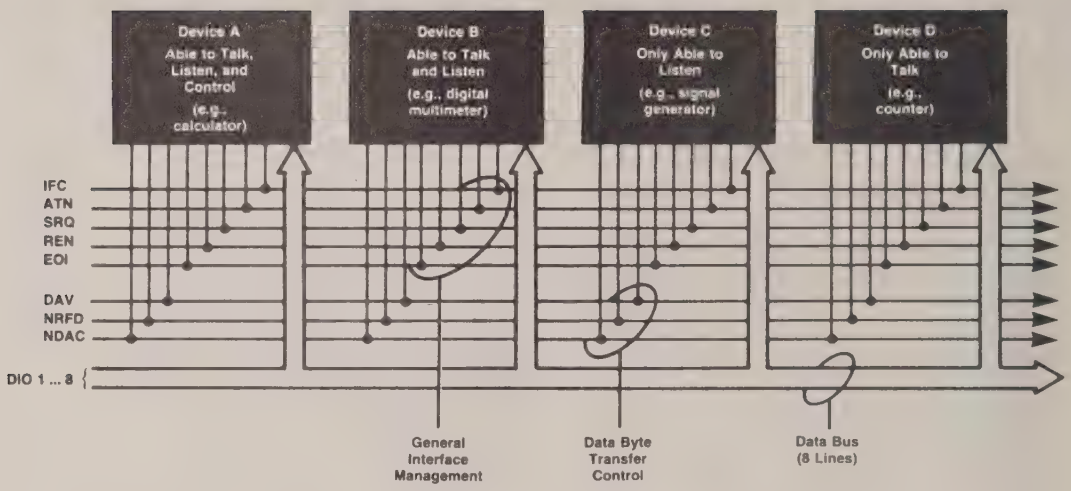


Figure 1-2 IEEE 488 BUS

1.2 DETAIL SPECIFICATIONS

The following specifications apply in general to all 4884 Series Couplers. Exact specifications for your model may be found by comparing its model number against the listed specifications.

1.2.1 Model Number Designation

4884 - X ——— General Model number

——— Option Code

-1	Special crystal
-3	Special paint
-4	No logo on front panel
-5	Custom logo on front panel
-7	Special program
-J	100/200Vac transformer

——— RS-232 to IEEE 488 Bus Coupler Model Number

1.2.2 IEEE 488 Bus Interface Functions

Numbers in parenthesis are applicable manual paragraph numbers.

Code	Description	Comments
SH1	Source Handshake	Included
AH1	Acceptor Handshake	Included
T5,TE5	Talker, Extended Talker	Talker only* (1.2.4)
L5,LE5	Listener, Extended Listener	Listener only* (1.2.5)
SR1	Service Request	Included
PP1	Parallel Poll	Included*
RLO	Remote, Local	No capacity
DC1	Device Clear	Included (1.2.6.1)
DT0	Device Trigger	Not implemented
C0	Controller	Not implemented

*Extended address capability can be included if parallel poll capability is deleted (3.4.2).

1.2.3 IEEE 488 Bus Specifications

Form	Sixteen lines, eight data and eight for control status messages. Data transfer is byte serial using 3 wire handshake. IEEE 488 command and address messages shown in Table 1-1.
Interface	Driver and receiver circuits TTL compatible. Outputs sink 40mA and drive over 20 meters of cables.
Address Capability	Address 31 Talk/Listen single addressed devices (addresses 0 thru 30) and 961 extended addressed devices.

1.2.4 Talker Format

Format established by user's serial input. There are no character restrictions. The 4884 accepts serial characters at the user's present baud rate, stores them, and outputs them on the IEEE 488 Bus when addressed as a Talker. Data characters are transmitted on a one-to-one basis in the Talk only mode.

1.2.5 Listener Format

Format established by the data characters received from the IEEE Bus while addressed as a Listener. Command characters received with attention on are not considered valid data characters. There are no 4884 character restrictions. The 4884 stores the data characters received from the IEEE Bus and transmits them serially when not addressed as a listener or as a talker. Data characters are received and transmitted on a one-to-one basis in the Listen only mode or when the internal buffer is full.

1.2.6 Special 488 Functions

1.2.6.1 DEVICE CLEAR

Clears internal buffers and resets RS-232 output.

1.2.6.2 DEVICE TRIGGER

Not implemented, no equivalent RS-232 function.

1.2.6.3 SRQ

The 4884 generates a Service Request Interrupt (SRQ) while not addressed as a talker, each time it receives a serial character or when the serial input buffer is full. SRQs can be restricted to being only generated on receipt of a ASCII carriage return character instead of any character by placing the rear panel EOM[2] switch in the ON position. SRQs can be completely inhibited by depressing the front panel SRQ INHIBIT switch.

1.2.6.4 SERIAL POLL RESPONSE

The 4884 responds to a serial poll by placing the following status characters on the data lines.

41 hex (decimal 65)	If the buffer contains a serial character or message
40 hex (decimal 64)	If the buffer is full or contains additional data
00 hex	If no data is available

1.2.6.5 PARALLEL POLL RESPONSE

The 4884 responds to a parallel poll by placing the Ready Status condition in the bit selected by the PPE command. The bit is a logic '1' if the READY light is on, logic '0' if off. The 4884 requires a minimum ATN off time of 250 microseconds before the parallel poll IDY pulse. Set internal jumper per paragraph 3.5.1.

1.2.7 Data Storage

Serial Input Data Buffer	220 Characters
Talk Data Buffer	220 Characters

[2]The EOM switch was labeled MUTE on units delivered prior to April 1981.

1.2.8 Serial I/O

RS-232 Output	Meets EIA RS-232C specifications for AA, AB, BA, BB, CA, CB, CC, CD and CF signals. 4884 RS-232 control signals are programmed as data terminal. The Coupler raises CA (request-to-send) and checks for a valid CB (clear-to-send), CC (data-set-ready), and CF (received-signed-detector) signals before outputting data. The Coupler drops CD (data-terminal-ready) when received data buffer is full.
20mA Output	Full duplex interface for a 20mA circuit paralleling the modem and the terminal RS-232 I/O. Teletype[3] keyboard sensing circuit uses + and - 12 Vdc.
Data Character	Internally switch selectable as: Even, odd or not parity 1 or 2 stop bits 5, 6, 7 or 8 bits
Baud Rate	Externally switch selectable as 110, 150, 225, 300, 450, 600, 900, 1200, 1800, 2400, 4800, 7200 and 9600 baud. Baud rates are crystal based, accuracy $\pm$0.1%.

[3]Teletype is a registered trademark of Teletype Corporation, Skokie, IL.

1.2.9 Physical Description

CONTROLS

POWER	Energizes unit.
RESET	Clears internal logic and buffers.
SRQ INHIBIT	Disables Talker's service request interrupts.
Address Switch	Rear panel switch assembly includes five address switches, Talk/Listen select, and the Only switch.
Baud Rate Switch	Rear panel assembly includes five frequency setting switches, a SOURCE selection switch, and the EOM switch.
Power Select	Rear panel slide switch selects 115 or 230Vac power.

INDICATORS

POWER	Illuminated when power is on.
READY	Illuminated when RS-232 control lines (CC and CF) are true (high).
TALKING	Illuminated when 4884's talk address recognized.
LISTENING	Illuminated when 4884's listen address recognized.

DESCRIPTION

Dimensions	8.5 in. wide x 3.5 in. high x 11.25 in. deep (21.6 cm wide x 8.9 cm high x 28.6 cm deep), excluding connectors.
Weight	6 pounds (2.7 kgm)
Connectors	RS-232 Interface, Cinch DB-25S. IEEE 488 Bus Interface, Amphenol 57-20240 with metric lock nuts.
Power Requirements	115 or 230Vac + 10%, 48-62Hz, 25 watts max. std. 100 or 200Vac $\mp$ 10%, 48-62Hz, (-J option) Fuse - 3AG, 1 ampere for 100-115 Vac - 3AG, 1/2 ampere for 200-230Vac
Temperature	-0°C to +50°C operating, -20°C to +70°C non-operating.

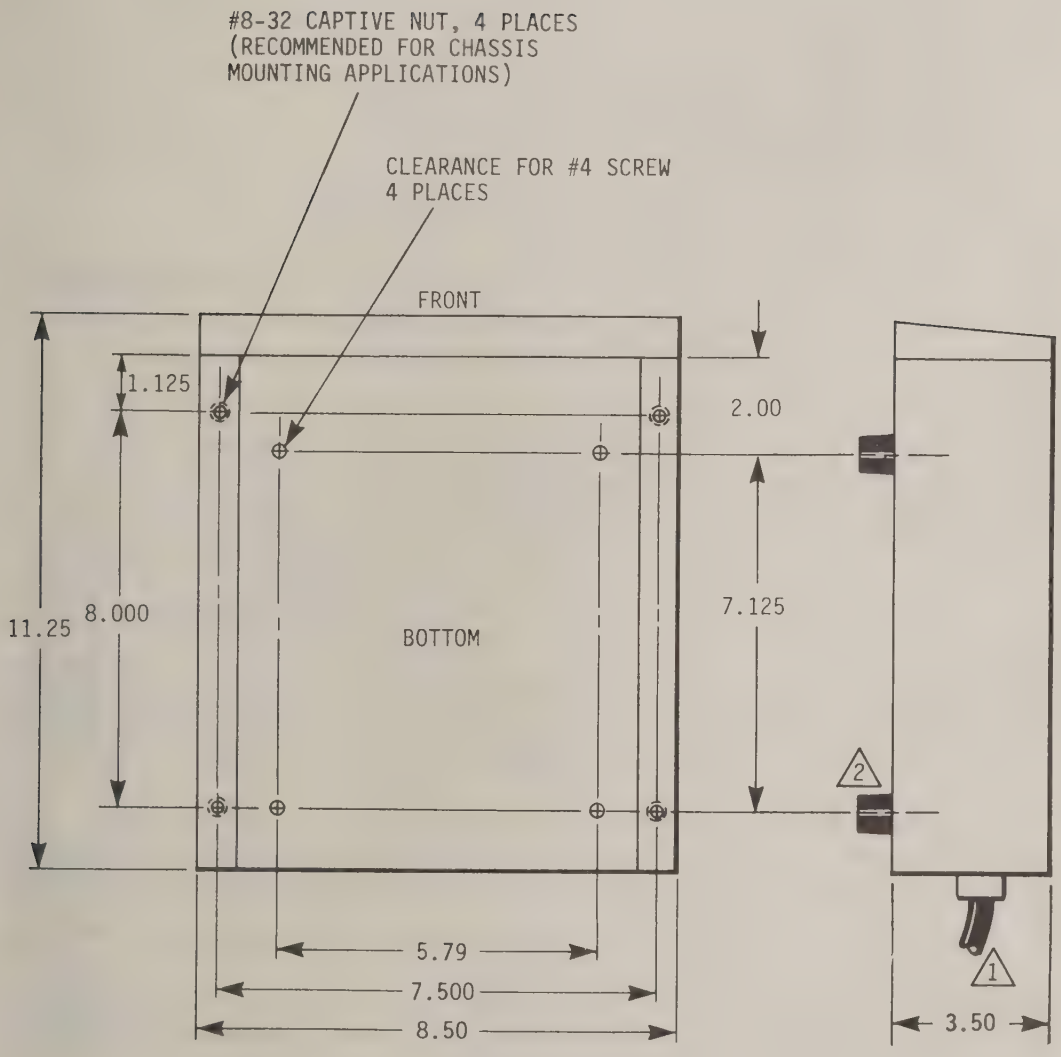


Figure 1-3 - 4884 Outline Dimensions

Notes: ⚠1 Six foot long removable cord
⚠2 Removable feet
3. All dimensions in inches

TABLE 1-1 IEEE 488 COMMAND AND ADDRESS MESSAGES

ASCII — IEEE 488 BUS MESSAGES (COMMANDS AND ADDRESSES) HEX CODES

MSD / LSD	0		1		2		3		4		5		6		7	
	ASCII	MSG	ASCII	MSG	ASCII	MSG[1]	ASCII	MSG[1]	ASCII	MSG[1]	ASCII	MSG[1]	ASCII	MSG	ASCII	MSG
0	NUL		DLE		SP	00	0	16	@	00	P	16	`		p	
1	SOH	GTL	DC1	LLO	!	01	1	17	A	01	Q	17	a		q	
2	STX		DC2		"	02	2	18	B	02	R	18	b		r	
3	ETX		DC3		#	03	3	19	C	03	S	19	c		s	
4	EOT	SDC	DC4	DCL	$	04	4	20	D	04	T	20	d		t	
5	ENQ	PPC	NAK	PPU	%	05	5	21	E	05	U	21	e		u	
6	ACK		SYN		&	06	6	22	F	06	V	22	f		v	
7	BEL		ETB		'	07	7	23	G	07	W	23	g		w	
8	BS	GET	CAN	SPE	(	08	8	24	H	08	X	24	h		x	
9	HT	TCT	EM	SPD	)	09	9	25	I	09	Y	25	i		y	
A	LF		SUB		*	10	:	26	J	10	Z	26	j		z	
B	VT		ESC		+	11	;	27	K	11	[	27	k		{	
C	FF		FS		,	12	<	28	L	12	\	28	l		|	
D	CR		GS		-	13	=	29	M	13	]	29	m		}	
E	SO		RS		.	14	>	30	N	14	^	30	n		~	
F	SI		US		/	15	?	UNL	O	15	_	UNT	o		DEL	

MEANING DEFINED BY PCG CODE

ADDRESSED COMMAND GROUP

UNIVERSAL COMMAND GROUP

LISTEN ADDRESS GROUP

TALK ADDRESS GROUP

SECONDARY COMMAND GROUP

PRIMARY COMMAND GROUP (PCG)

Notes:

1. Device Address messages shown in decimal
2. Message codes are:
   DCL — Devices Clear
   GET — Device Trigger
   GTL — Go to Local
   LLL — Local Lockout
   PPC — Parallel Poll Configure
   PPU — Parallel Poll Unconfigure
   SDC — Selected Device Clear
   SPD — Serial Poll Disable
   SPE — Serial Poll Enable
3. ATN off, Bus data is ASCII; ATN on, Bus data is an IEEE MSG.

2

Operation

2.1 UNPACKING AND INSPECTION

If shipping carton or instrument is damaged, call carrier immediately, and inspect Coupler for damage (scratches, dents, etc.). If unit is damaged or fails to meet specifications, notify ICS Electronics or your local sales representative immediately. Retain shipping carton and packing material for carrier's inspection. ICS will make arrangements for unit to be repaired or replaced without waiting for claim against carrier to be settled.

2.2 BENCH OPERATION

The Bus Coupler is ready for bench operation when shipped, with the exception of setting the rear panel escape and baud rate switches. See Section 3.1 for Address switch, Baud rate, EOM, and SOURCE switch setting instructions. See Section 3.4 for PROM program table modification instructions.

The unit is equipped with four feet for setting on other instruments. While capable of operation at elevated room temperatures, for best stability and long life, do not place the unit where it will be subjected to undue temperature rises.

2.3 RACK INSTALLATION

Rack installation is feasible only if a rack mounting kit was shipped with the instrument. To convert the unit for rack mounting, do the following:

a. Remove feet and cover.

b. Slide the 4884 into the rack mounting kit from the front until the front bezel is just outside of rack mount assembly.

c. Turn the rack mount kit on its side. Line up the 4884 case feet mounting screws with those in the rack. Use the furnished screws to unfasten unit in place.

d. Repeat steps a through c if a second unit is to be installed in the rack mount assembly. If a second unit is not to be installed, mount the dummy front panel in its place.

e. Place the cover on top of the rack and use the furnished screws to fasten the cover in place.

f. Install the rack mount assembly in the rack and attach cables to the unit(s).

g. To service or adjust units, reverse steps f through c.

CAUTION

ALWAYS REMOVE POWER FIRST BEFORE INSTALLING UNITS IN THE RACK MOUNTING KIT

2.4 POWER CONNECTIONS

The unit may be operated from either 115 or 230Vac, 50 or 60Hz power. A rear panel slide switch selects 115 or 230Vac operation. The unit is equipped with a three prong international power socket which accepts 115Vac American style power cords or 230Vac European style power cords.

The unit is equipped with a 1.0 ampere fuse for 115Vac use. Change fuse to 0.5 ampere for use with 230Vac power.

An optional 100/200Vac transformer is available for use in Japan and other countries.

2.5 IEEE 488 BUS CONNECTIONS

The unit is equipped with a 24-pin connection, J1, which mates with any 488 Bus Cable. All pin numbers and signals characteristics are per IEEE Specification, 488-1978. Signal - pin assignments are listed for reference purposes in Table 2-1.

TABLE 2-1 488 BUS CONNECTIONS (J1)

Pin	Signal	Pin	Signal
1	DI01	13	DI05
2	DI02	14	DI06
3	DI03	15	DI07
4	DI04	16	DI08
5	EOI	17	REN
6	DAV	18	DAV Ret
7	NRFD	19	NRFD Ret
8	NDAC	20	NDAC Ret
9	IFC	21	IFC Ret
10	SRQ	22	SRQ Ret
11	ATN	23	ATN Ret
12	Shield	24	Ground

2.6 SERIAL RS-232 (20 mA) CONNECTIONS

The 4884 Couplers have a 25 pin, EIA RS-232 compatible connector, J2, that contains all of the serial I/O signals listed in Table 2-2. Connector J2 is a Cinch DB-25S connector with female pins. There are four kinds of signals on connector J2:

1. RS-232 data and control signals to interface to a modem.
2. RS-232 data signals to interface to a terminal.
3. 20mA current loop signals to interface to a minicomputer.
4. 20mA current loop signals to interface to a 20mA Teletype.

The 4884 Coupler can be connected to a computer or other serial device in the following ways. The numbers shown in parenthesis are paragraph numbers that describe the appropriate cable design.

1. Directly to any computer's RS-232 I/O port (2.6.1).
2. Indirectly to a computer thru an RS-232 compatible modem (2.6.2).
3. To an RS-232 compatible terminal (2.6.3).
4. To a computer's 20mA I/O port (2.6.4).
5. To a Teletype or a 20mA terminal (2.6.5).

Note that the 4884 Coupler's RS-232 handshaking signals are designed to interface to a modem. Exercise caution when interfacing the 4884 to another type of device to assure that the RS-232 handshaking lines are properly connected. The handshaking line functions are:

CA - 4884 sets request-to-send signal on at the start of an output message and off at the end of a message. CA only sets on if CC and CF are high and CB is low.

CB - Clear-to-send signal must follow CA high for the 4884 to output data. Receiving device may pull CB low to stop the data transmission. If CB is not used, tie CA to CB.

CC
CF - Data-set-ready and Receive-signal-detector are checked for the READY light before setting CA, and both must be high for the 4884 to output data. The receiving device may pull either line low to stop the data transmission. If CC and CF are not being used, pull them high by jumpering them to J2 pin 24 with a 10 Kohm resistor.

CD - Data-terminal-ready is normally high and is set low four characters before the 4884's input buffer is full. Note that the 4884 will accept but not store serial data when the input buffer is full.

TABLE 2-2 J2 SERIAL I/O PIN ASSIGNMENTS

EIA Code	Signal/Function	Data/Signal Directions (in) (out)	Pin/No.
AA	Chassis ground	-	1
BA	Transmitted Data to Modem	→	2
BB	Received Data from Modem	←	3
CA	Request-to-Send	→	4
CB	Clear-to-Send	←	5
CC	Data Set Ready	←	6
AB	Signal ground	-	7
CF	Signal Detected	←	8
	-		9
	TTY KYBD - (-12v)	→	10
	TTY ENA JUMPER	-	11
	TTY ENA JUMPER	-	12
BA'	Terminal Keyboard, TTY KYBD+	←	13
	-	→	14
	TTY Printer +	←	15
	TTY Printer -	→	16
BB'	Received data to Terminal	→	17
CD'	Terminal DTR	←	18
CA'	Terminal RTS	←	19
CD	Data Terminal Ready	→	20
	CPU 20mA IN +	←	21
	CPU 20mA IN -	←	22
	CPU 20mA switch OUT +	→	23
	TTY KYBD + Bias (+12v)	-	24
	CPU 20mA switch OUT	→	25

2.6.1 Connection to a Computer's RS-232 Port

The 4884 can be connected directly to a computer's RS-232 I/O port by fabricating a cable similar to the cable shown in Figure 2.1. Check your computer's hardware manual for connector type, pin connections and BA and BB signal directions. The interconnection cable should not exceed fifty (50) feet in length.

Program the computer's serial I/O port to operate as a modem. Tie any unused RS-232 handshake signals to another signal as outlined in Section 2.6. Adjust both the computer and 4884 for the same baud rate and character format.

2.6.2 Connection to a Modem

The 4884 can be connected to most modems by fabricating the cable shown in Figure 2-1. The interconnection cable should not exceed fifty (50) feet in length. Tie any unused RS-232 handshake signals to another handshake signal as described in Section 2.6. Adjust the 4884 for the same baud rate and character format as the device at the other end of the modem data link.

2.6.3 Connection to a Terminal

The 4884 can be connected to a terminal, or any terminal-like RS-232 device, by fabricating a cable similar to the one shown in Figure 2.2. If your terminal device does not have a data set ready (CD) signal, tie the 4884's CC and CF signals to the 4884's pin 24 output. Also, you can omit the connection from the 4884's CD output to the terminal CC and CF signals if they are not used. Adjust both devices for the same baud rate and data character format.

2.6.4 Connection to a Computer's 20mA Port

The 4884 can be connected to a computer's 20mA drivers by using the optical isolator receiver - drivers on the 4884's serial I/O card. Consult your computer's hardware manual to determine signal polarity and connector type. Fabricate a cable that connects the computer's two output lines to the 4884 J2 pins 21 and 22. Connect the 4884's solid state "switch" output on pins 23 and 25 to the computer's keyboard sensing circuit.

CAUTION

> Observe proper voltage polarity when making connections to the computer by tieing like polarities together and do not exceed 30 volts across J2 pins 23 and 25.

Jumper the 4884's CA signal to CB and, then jumper pin 24 to CC and CF as shown in Figure 2-3. Add a 27 Kohm, ¼ watt resistor between J2 pin 24 and pin 3 to pull-up the 4884's BB input. Set both devices for the same baud rate and data character format.

2.6.5 Connection to a Teletype or a 20mA Terminal

The 4884 can be connected to a Teletype or any other 20mA current loop terminal-like device. If a Teletype is used, it must first be modified for 20mA, full duplex operation. Refer to the Teletype Manual or field service technicians for correct jumper strapping directions to achieve the 20mA, full duplex operation.

Refer to Table 2-2 for J2 pin assignments and Figure 2-3 for a Teletype cable. Connections to an ASR33 type Teletype are made at an internal connector, P2. Cable length is no problem as long as it does not exceed 1000 feet at 110 baud. Reduce the cable length proportionally for higher baud rates, i.e.: 366 feet for 300 baud.

WIRE LIST 4884 MODEM CABLE

EIA CODE	SIGNAL	COLOR	4884-J2 PIN No.	MODEM-J1 PIN No.
A A	CHS GND	BRN	1 ___	___ 1
B A	TRANS DATA	RED	2 ___	___ 2
B B	RCVD DATA	ORG	3 ___	___ 3
C A	RTS	YEL	4 ___	___ 4
C B	CTS	GRN	5 ___	___ 5
C C	DSR	BLU	6 ___	___ 6
A B	SIG GND	V10	7 ___	___ 7
C F	RLSD	GRY	8 ___	___ 8
C D	DTR	BLK	20___	___ 20

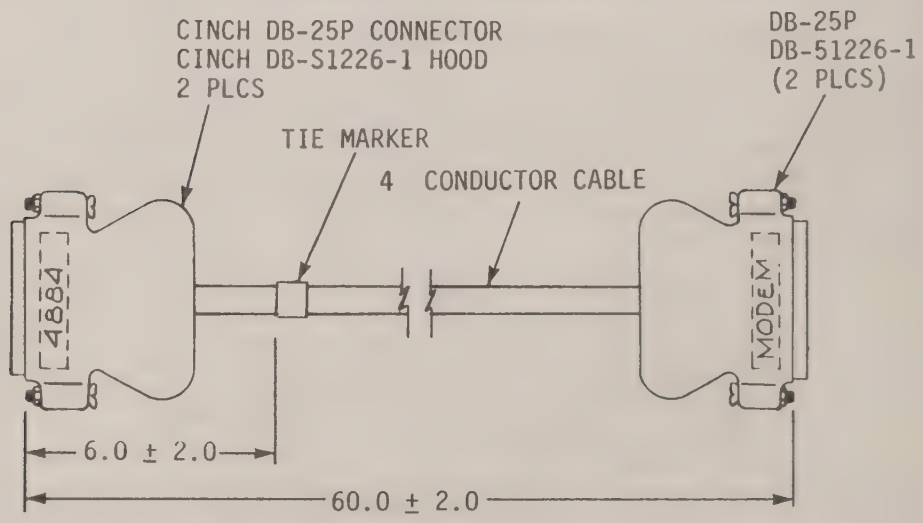


Figure 2-1 4884 Modem Cable Assembly

Note: 1. All dimensions are in inches

WIRE LIST 4884 TERMINAL CABLE

EIA CODE	SIGNAL	COLOR	4884-J2 PIN No.	TERMINAL J1 PIN No.
A A	CHS GND	BRN	1	1
B B'	RCBD DATA	RED	13	2
B A'	TRANS DATA	ORG	17	3
A B	SIG GND	VIO	7	7
C A'	RDY-TO-SEND		19	
C C	DSR	BLK	6	20
C F	RLSD		8	
C A	RTS		4	
C B	CTS		5	
C D	DTR	GRY	20	8
-	TERM DSR			6
-	TERM RTS			4
-	TERM CTS			5

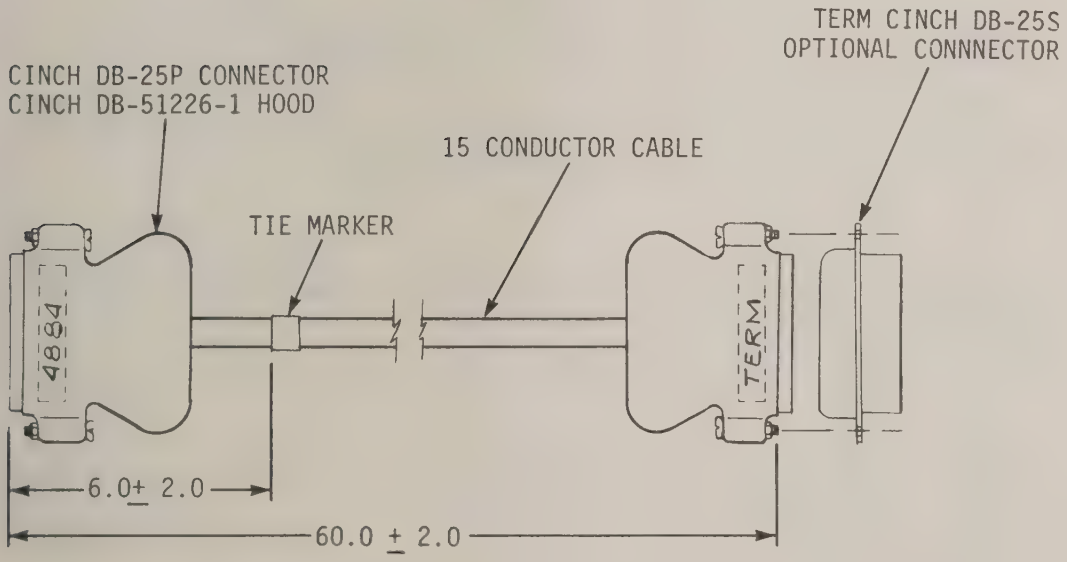


Figure 2-2 4884 Terminal Cable Assembly

Note: 1. All dimensions are in inches

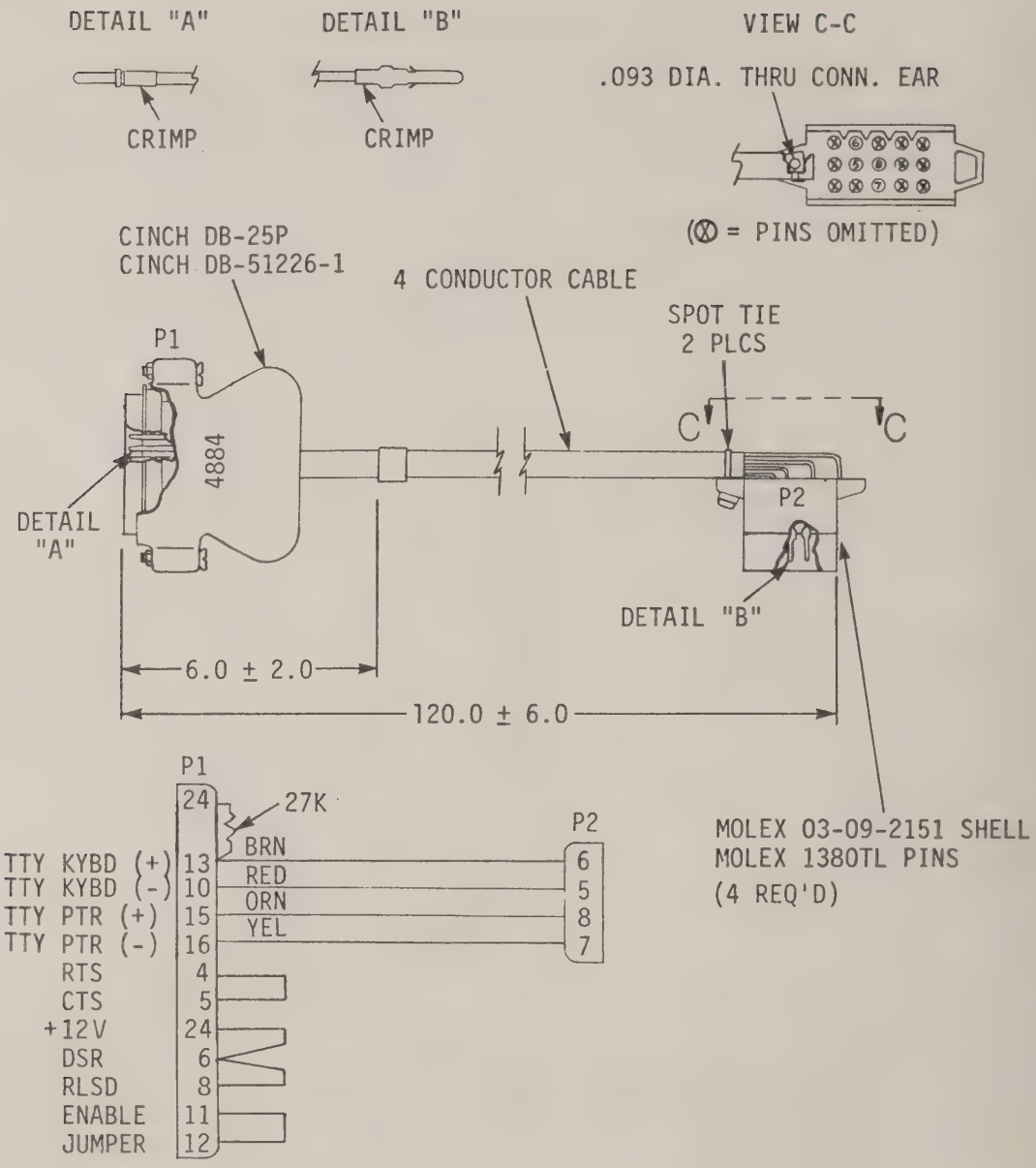


Figure 2-3 4884 TTY Cable Assembly

Notes:
1. Use 27 Kohms for a Teletype switch keyboard. Select a lower resistor for use with solid state switches, typically 4.7 Kohms.
2. All dimensions are in inches.

3

Operation

3.1 CONTROLS

3.1.1 Front Panel Controls

POWER	An alternate action push button that applies ac power to the interface. In is ON.
RESET	Momentary push button that resets the 4884's internal logic.
SRQ INHIBIT	An alternate action push button that prevents the 4884 Coupler from generating service requests. IN is the inhibit position.

3.1.2 Address Switch

The address switch assembly sets the Coupler address and establishes the Talk Only or Listen Only modes. The address switch is a miniature switch assembly with eight rocker switches that is located on the rear panel. From left to right, the switch positions are address bits 2^0, 2^1, 2^2, 2^3, 2^4, Talk, Listen and Only. See Figure 3-1.

For AUTO ADDRESSING, pick an unused Bus address between 0 and 30 decimal. Convert the address to binary and write it left to right, putting the LSB on the left, i.e., address 3 becomes:

1	2	3	4	5
1	1	0	0	0

Set the five address switches to the binary value and T, L, and O to off. Top in or switch up is on, or a logic 1; down or bottom in is off, or a logic 0.

For SECONDARY ADDRESSING, set the address switches (1-5) to the primary address value and modify the 4884's PROM as described in section 3.4.2.1. Press RESET after changing the primary address setting.

For TALK ONLY, set just the T and O switches on, all others off. Press RESET.

For LISTEN ONLY, set just the L and O switches on, all other off. Press RESET.

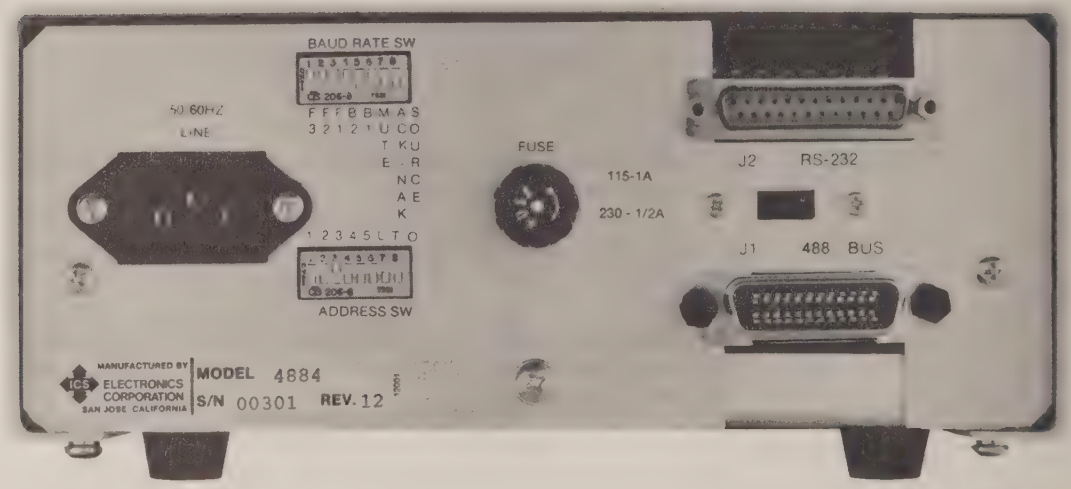


Figure 3-1 4884 Rear Panel

3.1.3 115/230 Switch

The Rear Panel 115/230 Switch adjusts the power supply for the ac line voltage. Check the switch setting prior to using the instrument. Use a small screw driver to slide the switch until 115 or 230 appears through the slot in the rear panel. For 115Vac operation, use the 1 ampere fuse supplied with the unit. For 230Vac operation, substitute a 0.5 ampere 3AG fuse. With the optional 100/200Vac transformer, the 115 position selects 100Vac and the 230 position selects 200Vac operation. Disconnect the power cord before switching voltages.

3.1.4 Baud Rate Switch Assembly

The Rear Panel Baud Rate Switch Assembly contains the baud rate frequency, EOM, S (spare), and serial data SOURCE selection switches. Table 3-1 shows the switch settings for the standard baud rates.

TABLE 3-1 BAUD RATE SWITCH SETTINGS

Baud Rate	Switches F3	F2	F1	B2	B1
9600	1	1	1	1	0
4800	1	1	0	1	0
2400	1	0	1	1	0
1200	1	0	0	1	0
600	0	1	1	1	0
300	0	1	0	1	0
150	0	0	1	1	0
7200	1	1	1	1	1
3600	1	1	0	1	1
1800	1	0	1	1	1
900	1	0	0	1	1
450	0	1	1	1	1
225	0	1	0	1	1
110	0	0	0	0	1

NOTE

There are two types of minature switches used on the 4884. Depress the rocker switches on the top for logic '1'; on the bottom for logic '0'. Slide switches are moved up for logic '1', down for logic '0'.

The EOM rocker switch selects either SRQ (service request interrupt) on each received character or only when a carriage return is received. The 4884 Coupler will only generate SRQs if not addressed as a Talker or a Listener and the SRQ INHIBIT switch is off. Depress the EOM rocker on the top to select SRQs on carriage return only; on the bottom for SRQs on any received character.

The S (spare) switch is not used by the 4884 and may be ignored.

The SOURCE switch selects either the Modem or Terminal serial input pins as the coupler's command source. Position the switch in the down or off position if the data is from the Modem input on J2 pin 3 or pins 21-22. Position the switch in the up or on position if the data is from the Terminal input on J2 pin 13 or pins 23-25.

3.1.5 Data Character Format Switch

The internally mounted Data Character Format Switch is located on the upper board as shown in Figure 3-2. The Data Character Format Switch is factory preset for a serial character having 1 start bit, 7 data bits, an even parity bit, and 1 stop bit. To change the switch setting, remove the top cover and set the switch rockers by following the instructions in Table 3-2.

TABLE 3-2 DATA CHARACTER FORMAT SWITCH SETTINGS

Switch Rocker	Position	Function
EPE	0	Selects odd parity if PINH = 0
	1*	Selects even parity if PINH = 0
WS2,WS1	-	Selects number of data bits as follows:
		WS2 WS1 Bits 0 0 5 0 1 6 1 0 7* 1 1 8
2 STOP	0*	Selects 1 stop bit
	1	Selects 2 stop bits
PINH	0*	Enables parity bit generation
	1	Inhibits parity bit generation
		* (Factory Setting)

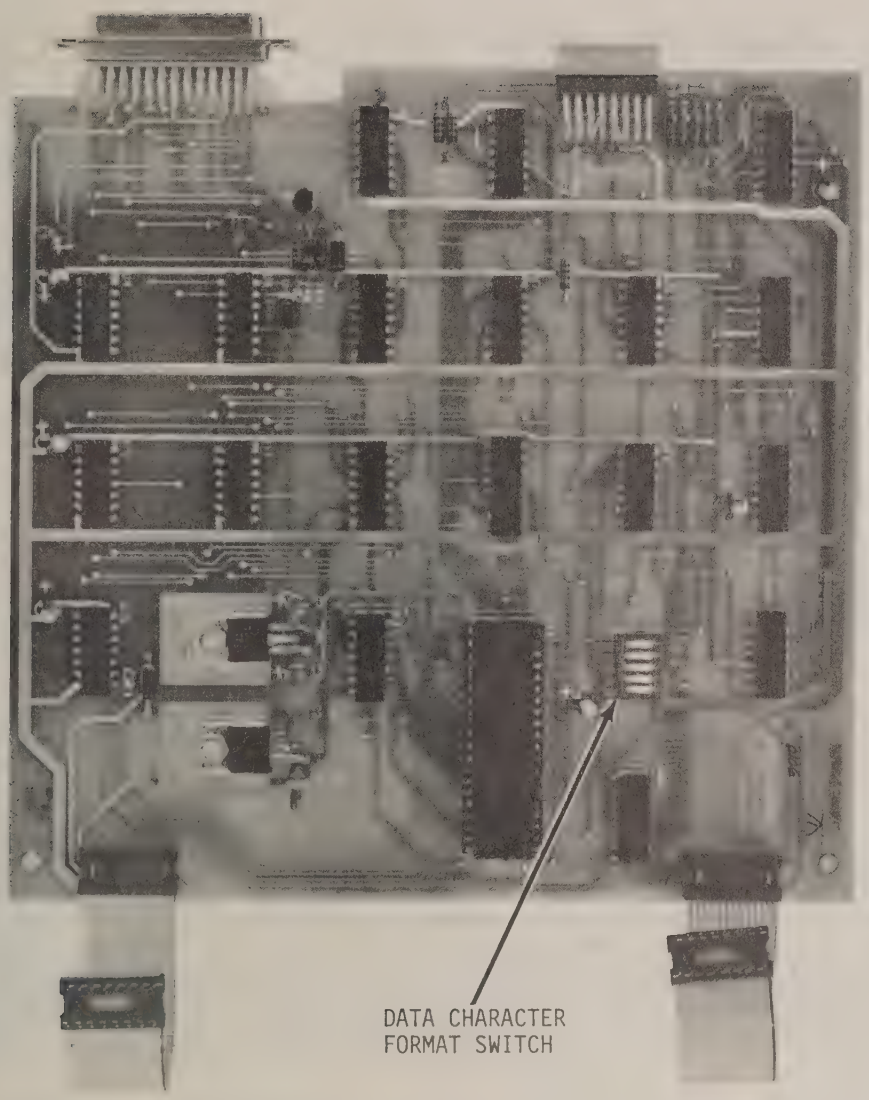


Figure 3-2 Data Character Switch Location

Note: 1. Logic '1' is on the left hand side of the switch.

3.2 OPERATING INSTRUCTIONS

3.2.1 Pre-Operation Setup

Before using the 4884 RS-232/IEEE 488 Coupler, design and fabricate the serial interface cables. Refer to Section 2.6 for cable design instructions. Use the cable to connect the serial device to the 4884's RS-232 connector, J2.

Use an IEEE 488 Bus cable to connect the 4884 to the Bus controller or to another Bus compatible instrument. Set the address, power, and baud rate switches per Sections 3.12, 3.1.3, and 3.1.4. Plug the power cord into an ac power receptacle.

3.2.2 Operation

Depress the POWER switch to turn the 4884 on. The POWER indicator will come on. Place the SRQ INHIBIT switch in the Off position (switch out) and apply power to the device connected to the Coupler. The device's controls should be set for remote operation and control. The READY light will come on to indicate that the RS-232 signals connected to the Coupler are in their normal or ready state. If the READY light is not on, check the device for any error conditions and the cable wiring per Section 2.6. Do not proceed if the READY light is off since the RS-232 device is either turned off or disconnected.

The controller should send an IFC command to reset the Coupler. The controller may also use the Bus Device Clear or Selected Device Clear commands to reset the 4884.

The controller can output data through the 4884 Coupler at any time by addressing the Coupler as a listener. The LISTENING indicator is on while the Coupler is in the Listen state. While in the Listen state, the Coupler stores all Bus data characters. If the buffer becomes full, the 4884 slows the Bus handshake rate down to the serial character rate and starts outputting the stored data, first character first. If the buffer is not full, the 4884 starts its serial transmission as soon as the controller puts it in the unlisten state. The 4884 will not output data while in the Talk or Listen state except for the buffer full condition described above.

The Coupler will detect any character received on the serial interface and store it in its internal memory. If not in the Talk or Listen state, and depending upon the EOM switch position, the Coupler will generate a Service Request on each character or upon receipt of a complete message (CR sensed). The Coupler will then generate a Service Request by pulling the Bus SRQ signal low. The Controller may set the serial poll mode with the SPE command and perform a serial poll to find the device which requested service. The Coupler responds 41 hex if it has a message, 40 hex if the buffer is full, and 00 hex if it has no data. The Service Requests can be eliminated by placing the SRQ INHIBIT switch in the INHIBIT position (IN).

The Controller then terminates the serial poll mode with an SPD command and puts the Coupler in the Talk mode so that the Coupler can transmit the data onto the Bus. When all of the stored data has been transmitted, the Coupler remains in the Talk state until told to untalk by the controller. Any additional serial data received while the Coupler is in the Talk state will be transmitted to the controller. The TALKING indicator is on while the interface is in the Talk state.

The Coupler will also generate a Service Request if the input buffer becomes full. The Coupler's serial poll response for a full buffer is 40 hex. To empty a full buffer, the controller should place the Coupler in the Talk mode, input a message and repoll the Coupler. The controller should repeat the above steps until the poll response is 00 hex.

The Controller can perform a parallel poll at any time to check on the status of the 4884's READY indicator. This indicator combines the RS-232 status signals into one status bit as indicated by the Controller's configure command. The Controller performs the parallel poll by sending EOI on with ATN. The 4884 detects the presence of the EOI and ATN signals and outputs the Ready status bit on the data line indicated by the configure command. The 4884 detects the parallel poll disable command and resets the configure bit pattern to zero. The status bit is a logic '1' if the READY light is on. See Section 3.5 for enabling the parallel poll function.

3.3 USER PROGRAM AIDS

This section contains program steps designed to assist the user in getting the 4884 RS-232 Coupler to operate with the Bus Controller. The typical Bus Controller may be a Desktop Graphic Computer, (Tektronix 4051), a programmable calculator (HP 9825, Wang 2200), or a custom controller (includes minicomputer interfaces and hobby computers). While the following programs are written for the Tektronix 4051 Terminal, HP 9825 Calculator, Commodore PET 2001 computer, and the Fluke 1720A Controller, they can easily be modified for use on most programmable calculators and custom controllers. Paragraph 3.3.1 contains sample Tektronix 4051 programs, paragraph 3.3.2 contains sample HP 9825 programs, paragraph 3.3.3 contains sample PET programs, and paragraph 3.3.4 contains sample Fluke 1720A programs.

3.3.1 Tektronix 4051 Programs

The Tektronix 4051 is programmed in BASIC Language. In BASIC, data is normally moved to and from Bus devices by PRINT and INPUT commands. Both of these commands leave the Coupler in its idle state at the end of the data transmission.

3.3.1.1 SIMPLE TALK PROGRAM

This program inputs data from the 4884 Coupler and displays it on the 4051's CRT.

Initial Steps - Connect the Coupler to an RS-232 terminal or device which generates serial input data. Set the 4884 rear panel address switch to the desired address. The decimal value of the 5 switch bits is its primary address. Compute the Tektronix talk decimal address value by adding 64 to the primary address value as shown below:

$$\begin{aligned}\text{Talk decimal address} &= 64 + 2^0 + 2^1 + 2^2 + 2^3 + 2^4 \\ &= 64 + 0 + 0 + 0 + 0 + 16 \\ &= 80\end{aligned}$$

Program

```
                100  -  WBYTE @ (decimal address):
becomes         100  -  WBYTE @ 80;
                110  -  RBYTE A,B,C,D,E,F,G,H,I,J,K
                120  -  PRINT  A,B,C,D,E,F,G,H,I,J,K
                130  -  END
```

Use letters A thru K to input a string of 11 characters from the 4884. Test format is 10 data characters, Carriage Return and Line Feed. The 4051 will ignore the Line Feed following the Carriage Return. Modify the above program for different formats.

Enter 'RUN' and transmit the serial characters (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, CR LF) into the 4884. The 4884's TALKING light will come on and the data will appear in column format on the 4051's CRT as shown below:

```
100   -  WBYTE @ 80;
110   -  RBYTE  A,B,C,D,E,F,G,H,I,J,K
120   -  PRINT  A,B,C,D,E,F,G,H,I,J,K
RUN   -  100
```

Serial input is 0, 1, 2,...9 CR LF

48	48	50	51
52	53	54	55
56	57	13	

Figure 3-3 4051 Display for Sequential 0 thru 9 Ten Digit Input

3.3.1.2. HI LEVEL TALK PROGRAM

Program uses Input command to input data and display it on the 4051's CRT. Use with single or extended address units.

Initial Steps - Connect the Coupler to the serial source and set its desired address as described in Section 3.3.1.1. Compute the 4884's decimal address as shown below and use it directly in the 4051's INPUT statement.

Decimal Address $= 2^0 + 2^1 + 2^2 + 2^3 + 2^4$

$= 0 + 0 + 0 + 0 + 16$

$= 16$

Program:

```
            200  -  INPUT @ (Address), 32:A
becomes     200  -  INPUT @ 16, 32:A
            220  -  PRINT A
            220  -  END
```

A is a numeric variable and the 4051 will input all data until it receives a carriage return. Since A is a numeric variable, all non-numeric characters will be ignored. The 32 in line 200 causes the 4051 to delete the secondary address message since the standard 4884 decodes the secondary address message as a Parallel Poll Enable command. Refer to Section 3.4 for instructions on converting the 4884 to recognize the secondary address. Enter 'RUN' and transmit data into the 4884 Coupler. The 4884's TALKING light will come on and the data will appear on the 4051's CRT in floating point format.

ie '1.23456789E+8' for the same sequential ten digits as in 3.3.1.1.

To input text from the 4884, use a string variable in the 4051, i.e.: covert A to A$ and add a dimension statement for A$.

3.3.1.3 SQR INTERRUPTS

If the data is being generated by a free running device, there is a good chance that the 4884 could have received the data before the 4051 executed the RUN command. In this case, the 4884 will set the service request (SRQ) line low, indicating that it has a message for the terminal. The 4884 will automatically reset the SRQ line when it is allowed to 'Talk' by the controller. However, the 4051 will sense the SRQ line and issue an error statement like:

"NO SRQ ON UNIT IN LINE 200 - MESSAGE NUMBER 43"

This error message indicates that the user failed to tell the 4051 what to do with the service request. The problem is corrected by adding the following statements to the program

```
100   -  ON SRQ THEN 200          added in main body of program
110   -
 .
 PROGRAM OR LOOP TO 110
 .
 .
200   -  INPUT @ 16, 32:A         Performs input operation and returns
210   -  PRINT A                  to main program.
220   -  RETURN
```

If there are two or more 4884s on the Bus, the program can be written to find which device requested service, and answer it. To do this, the controller conducts a serial poll of the possible talkers on the Bus. The 4051 program to do the serial poll is:

```
100   -  ON SRQ THEN 300          SRQ enable
110
 .
 PROGRAM OR LOOP TO 110
 .

200   -  INPUT @ 16, 32:A         Device 16 service routine.
210   -  PRINT A
220   -  RETURN

300   -  POLL C,D: 16;17          Poll devices 16 and 17. Go to 200
310   -  GO TO C OF 200, 320      for device 16, 320 for device 17.
320   -  RETURN
```

3.3.1.4 SIMPLE LISTEN PROGRAM

Program outputs data from 4051 through the 4884 Coupler.

Initial Steps - Connect the RS-232 device to be controlled to the 4884 serial connector J2. Set the rear panel address switches and calculate the listener decimal address by adding 32 to the sum of the turned on address switches' decimal value as follows:

$$\text{Listener decimal address} = 32 + 2^0 + 2^1 + 2^2 + 2^3 + 2^4$$

$$= 32 + 0 + 0 + 0 + 0 + 16$$

$$= 48$$

Program

```
                100   -  WBYTE @ (decimal address): data
becomes         100   -  WBYTE @ 48:
                110   -  WBYTE 48,49,50,51,52,53,54,55,56,-57
                120   -  END
```

Enter RUN and program outputs the numbers 0 thru 9 to the 4884 Coupler. The 4884 outputs the ten digits in serial form on connector J2. The '-' in front of the '57' in line 100 causes the 4051 to assert the EOI signal with the last data character, thereby ending the output data message.

3.3.1.5 HI LEVEL LISTEN PROGRAM

Program uses higher level print command to output data. Compute the instrument address as done in 3.3.1.2.

Program

```
200   -  PRINT @ 16, 32: "0123456789"
210   -  END
RUN
```

This program outputs the same 10 digits as done in 3.3.1.4, but lets the 4051 do the address and number conversion. Data transmission starts when the last character is received and the 4884 is put in the unlisten state.

The 4051 can output text to the 4884 by converting the PRINT command to use a string variable i.e.:

```
200   -  PRINT @ 16, 32: A$
```

3.3.1.6 SECONDARY ADDRESSING

The 4884 can be converted to accept secondary addresses by following the instructions in Section 3.4. The 4884 uses a fixed secondary address to identify itself, not as a function command. To use a secondary address, put the preset secondary address in place of the 32 in line 200 in the above program.

3.3.2 Hewlett-Packard 9825 Calculator Programs

The HP calculator is programmed in HPL Language which is similar in many respects to the Tektronix BASIC language. However, the user should keep the following differences in mind: the HP higher level 488 Bus instructions do not return the devices on the 488 Bus to the 'unlisten' or 'untalk' state as do the corresponding Tektronix commands; all Talk sequences should be terminated with an 'untalk' command; also, the HP commands automatically end output transmissions (i.e.: wrt) with a line feed and carriage return rather than with the EOI signal as does the Tektronix.

The following examples were written for use on a HP 9825 calculator equipped with an Extended I/O ROM, and are intended to assist the user in quickly getting his system on line. The same programs can be converted for use on an HP 9830 calculator. The two main conversion rules are: delete the 7 in the 'cmd' instructions; and rewrite the arithmetic operations. Check your 9830 manual for the equivalents for the other instructions used in the sample programs.

3.3.2.1 HP ADDRESS TEST PROGRAM

Program #1 outputs command characters to put the 4884 Coupler in the Talk and Listen states. Program #2 demonstrates the 'cmd' statements and checks address operation.

Initial Steps - Look up Listen and Talk addresses in a 488 ASCII code chart. Hex address 04 is '$' for Listen and 'D' for Talk. "?_" are the unlisten, untalk commands.

Program

Program #1

```
0: "1-Device 04
 addr test :
1: cmd 7; "?_"
2: wait 50
3: cmd 7; "$"
4: wait 50
5: cmd 7; "D"
6: wait 50
7: gto 1
8: end
*9187
```

Program #2

```
0: cmd "? _"
1: dsp A+1
2: wait 500
3: cmd 7; "
4: wait 500
5: cmd 7; A"
6: wait 500
7: A+1→A
8: if A=1000000;
 gto "BE"
9: gto 0
10: "BE";A+4
11: B+1→B
12: gto 0
13: end
*16564
```

Figure 3-4 HP Address Check Programs

The 9825 uses code 7 in the 'wrt' and 'red' instructions to address the 488 Bus adapter. Press 'RUN' and the program sequentially clears the 4884 lights, turns the LISTENING light on, and then the TALKING light in 0.5 second steps. Program 2 counts and displays the number of times the program goes through a complete loop.

3.3.2.2 HP READ - WRITE PROGRAM

This program outputs a fixed number to the 4884 Coupler, reads data from the 4884 Coupler, and displays what was read. This program is used with single address, 4884 Couplers.

Initial Steps - Connect the Coupler to the Calculator's 488 Bus Adapter cable. Plug the adapter into the calculator. Set the 4884 rear panel address switches to the desired address. For address 04 Hex, set switch 3 on and all other switches off. Connect the Coupler to a 'loop around' test connector or to a terminal. The loop around connections are:

2 - 3
4 - 5
6 - 8 - 20

Program

```
0: 1234567890→A
1: wrt 704,A
2: cmd 7,"?"
3: wait 100
4: red 704,B
5: dsp B
6: wait 1000
7: gto 0
*9484
```

Figure 3-5 HP Basic Read/Write Program

Press 'RUN'. The Calculator will address the 4884 as a listener and output the string "1234567890 CR LF" to it. The sequence "1234567890 CR LF" will appear serially on the 4884's output line. The Calculator will put the 4884 into the Talk mode. Any data entered into the 4884 will be transferred to the Calculator and displayed. (Data must end with a LF for the HP 9825 to sense the end of the data string.)

3.3.2.3 HP SRQ INTERRUUPTS

When data is being inputted into the 4884 by an external device, the 4884 could be ready to send data before the calculator puts the 4884 into the 'Talk' state. The 4884 will generate a service request interrupt when it receives data if it is not in the 'Talk' state. The following example shows how to use the SRQ interrupt to input data.

Initial Steps - Write an interrupt enable command in the main program body. Write a special data handling routine to input the data. Set the 4884's address to 04 hex.

Program

```
0: 0→B
1: cmd 7, "SP"
2: eir 7
3: wait 500
4: gto 0
5: end
6: "SRQ": spl "04
   )→R
7: if R#65;ret
   "DSP"
8: red 704,B
9: wrt 704,B
10: "DSP":cmd 7,
   "?_"
11: prt R,E
12: dsp R,E
13: wait 400
14: eir "SRQ"
*B36
```

Printout

```
                65.00
1234567890.00
                65.00
1234567890.00
                65.00
1234567890.00
                65.00
1234567890.00
                65.00
1234567890.00
                65.00
1234567890.00
                65.00
1234567890.00
```

Figure 3-6 HP SRQ Interrupt Program

The 4884 generates an interrupt when it receives a data message. The interrupt causes the program to branch to SRQ, read the data, and display it. The untalk command (cmd 7, '__') is mandatory to set-up the 4884 for the next interrupt. The program tests the Coupler to see if it had requested service by storing the serial response in variable 'R'. The program only attempts to input data if the response was 65 (41 hex). The printout was made by inputting a 10 digit data string and LF into the Coupler.

3.3.3 Commodore PET Programs

The PET uses the BASIC language to control the IEEE BUS. It works well as a Bus controller with the following exceptions:

1. If a device requested to Talk does not respond within 65 milliseconds the PET can crash, with recovery possible only by turning power off and then back on.

2. Certain ASCII characters cannot legally be inputted over the IEEE Bus, i.e., (colon).

3. The PET does not use the ASCII character set internally and does not automatically convert ASCII characters from the Bus into the PET character codes.

The following sample demonstrates how to surmount some of the more common PET problems.

3.3.3.1 Sample PET Program

Initial Steps - Connect the 4884 to a PET and to a terminal. Set the 4884's address to 04 hex. Start the PET's program and enter a data string into the 4884 from the terminal.

```
10      REM ENABLE LOWER CASE
20      POLI 59468, 14
30      REM CHECK FOR SRQ
40      OPEN 1,4
50      INPUT #1, A$
60      A=PEEK (59426)
70      IF PEEK (59427) AND 128 THEN GOSUB 1000
80      REM SUB 1000 IS THE INPUT ROUTINE
90      GO TO 70

1000    REM INPUT ROUTINE
1010    GET#1,C$
1020    IFC$=' ' THEN 1010
1030    REM LOOP UNTIL CHARACTER IS NOT A "NUL"
1040    IF C$=CHR$ (10)  THEN 1010
1050    REM IGNOR LINE FEEDS
1060    IF C$=CHR(13)  THEN 1100
1070    REM  CARRIAGE  RETURN  INDICATES  END  OF
        MESSAGE
1080    GO SUB 3000
1090    REM SUB 3000 WOULD BE A ASCII-TO-PET CON-
        VERSION ROUTINE IF DESIRED
1100    B$=B$+C$
1110    GO TO 1010
1120    PRINT B$
1130    B$=" "
```

3.3.3.1 Sample PET Program (continued)

```
1140        REM CLEAR B$
1150        A=PEEK (59426)
1160        REM RESET SRQ
1170        RETURN
```

Figure 3-7 PET Input Program

This sample program inputs data from an 4884 Coupler and displays it on the PET's CRT. The program goes into a loop waiting for the SRQ (service request signal) from the 4884 Coupler indicating that the 4884 Coupler has a complete message (ending in CR) in its internal buffer. The program then calls an input routine that inputs the message one character at a time until a carriage return is detected. The input routine then displays the message and returns to the calling routine.

3.3.4 Fluke 1720A Programs

The Fluke 1720A Instrument Controller was designed as an IEEE-488 Bus Controller. The 1720A is programmed with an enhanced BASIC language that contains unique instructions for implementing the IEEE-488 Bus commands. PRINT and INPUT are the primary data transfer instructions. INIT initializes the Bus and CLEAR@ generates the selected device clear command. The user should note that the following 1720A instructions behave as follows:

WBYTE	Leaves ATN as last used. The Bus should never be left idle with ATN on for any length of time since the 4884 goes into an acceptor wait loop and expects to receive a command or address any time ATN is on.
INPUT	Leaves the addressed device a Talker.
PRINT	Leaves the addressed device a Listener.
RESUME	Required after an interrupt to return to the main body of the program.

3.3.4.1 Fluke Address Test Program

This address test program uses the WBYTE instruction to output address characters from a preset array to sequence the 4884 front panel lights. This is a good program to use to check-out a new device. This program is similar in concept to the one shown in Figure 3-4 for the HP 9825 Calculator.

Initial Steps - Connect the 4884 to the Fluke 1720A. Set the 4884 address switch to address 4 or change the decimal values in lines 1030 and 1040 to match the device's address.

```
1000  DIM T%(3%)
1010  T%(0%) = 512% + 63%                    ! ATN + UNL
1020  T%(1%) = 512% + 95%                    ! ATN + UNT
1030  T%(2%) = 512% + 36%                    ! ATN + MLA 4
1040  T%(3%) = 512% + 68%                    ! ATN + MTA 4
1050  WBYTE PORT 0, T%(0%..1%)               ! SEND UNL & UNT
1060  WAIT 100%                              ! 100 ms.
1070  WBYTE T%(2%)                           ! SEND MLA 4
1080  WAIT 100%
1090  WBYTE T%(3%)                           ! SEND MTA 4
1100  WAIT 100%
1110  GOTO  1050                             ! AGAIN
1120  END
```

Figure 3-8 Fluke Address Test Program

3.3.4.2 Fluke SRQ Loop Test

This program uses high level type commands to loop data out and back through a 4884. The 1720A is programmed to output a time-of-day string (line 1080), wait for the 4884's SRQ (line 1110) and then input the data. The 1720A will display both the 4884's serial poll response(s) and the input string (S$) as they are updated, each 200 milliseconds.

Initial Steps - Connect a loop around jumper to the serial data pins on the 4884's J2 connector as described in 3.3.2.2. Connect the 4884 to the 1720A and set the 4884's address switch to 04.

```
1000 !   * * * *      SRQ LOOP TEST       * * * *
1010 !
1020  PRINT CHR$(27)+"[1#"                  ! DOUBLE SIZE CHARS
1030  DIM T%(2%)
1040  T%(0%) = 512% + 63%                   ! ATN + UNL
1050  T%(1%) = 0%                           ! CLEAR ATN WITH NULL
1060  ON SRQ PORT 0% GOTO 5000              ! ENABLE SRQ INTERRUPT
1070  INIT PORT 0%  \  WAIT 100%            ! RESET BUS
1080  PRINT @4, NUM$(TIME)                  ! SEND "TIME OF DAY" STRING
1090  WBYTE T%(0%..1%)                      ! SEND UNL & CLEAR ATN
1100 !
1110  WAIT FOR SRQ                          ! W A I T I N G ...
1120 !
1130  PRINT CPOS(4%,0%)                     ! POSITION CURSOR
1140  PRINT "SERIAL POLL STATUS =", S%      ! DISPLAY SER POLL STATUS
1150  PRINT "INPUT =", S$                   ! DISPLAY INPUT DATA
1160  WAIT 200%   \   GOTO 1080             ! AGAIN
1170  END
1180 !
4999 !        SERIAL POLL INTERRUPT SERVICE ROUTINE
5000 S% = SPL(4%)                           ! READ STATUS
5010 IF S%=65% THEN INPUT @04, S$ ELSE S$=""  ! INPUT STRING
5020 RESUME 1130
```

Figure 3-9 Fluke SRQ Loop Program

Enter RUN on the 1720A and press the RETURN key. The 1720A will display the 4884's response to the serial poll (line 5000) and the input data string (line 5010). Note that the UNL and clear ATN instruction on line 1090 is necessary to free the 4884 so it can output the serial data given to it on line 1080. The 1720A's PRINT instruction does not automatically unlisten the device at the end of the data transfer.

3.4 INTERNAL PROGRAM CHANGES

The user can modify the 4884's performance by altering the contents of various program tables stored in a UV erasable PROM. User alterable tables include: secondary address, and EOM switch character. General directions for modifying the PROM are given in Section 3.4.1., and specific table locations and definitions are covered in Section 3.4.2. Note that standard 4884s use only one PROM although the lower board has space for two PROMs.

3.4.1 4880 PROM Alteration Instructions

Altering the 4884's PROM requires the use of a PROM Programmer that can erase and program 2708 PROMs, and a minimum of 2 spare 2708 PROMs. Do not disassemble the Interface until you have located a PROM Programmer and have the spare PROMs. If a PROM Programmer is not available locally, you can request a PROM programmed to your exact configuration directly from ICS. Perform the following steps to change or alter the 4884 PROMs.

a) Disconnect all cables and power cord from the 4884 Interface.

b) Remove the four screws holding the cover to the bottom plate. Tilt the unit to slide the electronics assembly out the front.

c) The 2708 PROM is located on the right rear side of the main (lower) board. Locate the PROM to be changed and use a flat bladed tool to pry it evenly up out of its socket. Skip d) if the PROM is to be replaced by a factory furnished PROM. See Figure 3-6.

d) List the section of the PROM to be changed and verify that it matches the tables given in Section 3.4.2. Make the changes by duplicating the good portions of the PROM onto a new PROM. Program in all changes and check by listing them back. Verify that all other portions of the original PROM have been duplicated on the new PROM. Do not erase the original PROM.

e) Place the new PROM back in the socket. Line the PROM's pins up carefully with the socket and use a rocking motion to push the PROM into the socket. Check to see that all pins went into the socket and that none were bent underneath.

f) Reverse steps b) and a) to close the unit. Make sure the switch caps are through the opening in the front panel before tightening the rear panel holding screws.

g) Erase the original PROM only after thoroughly testing the interface.

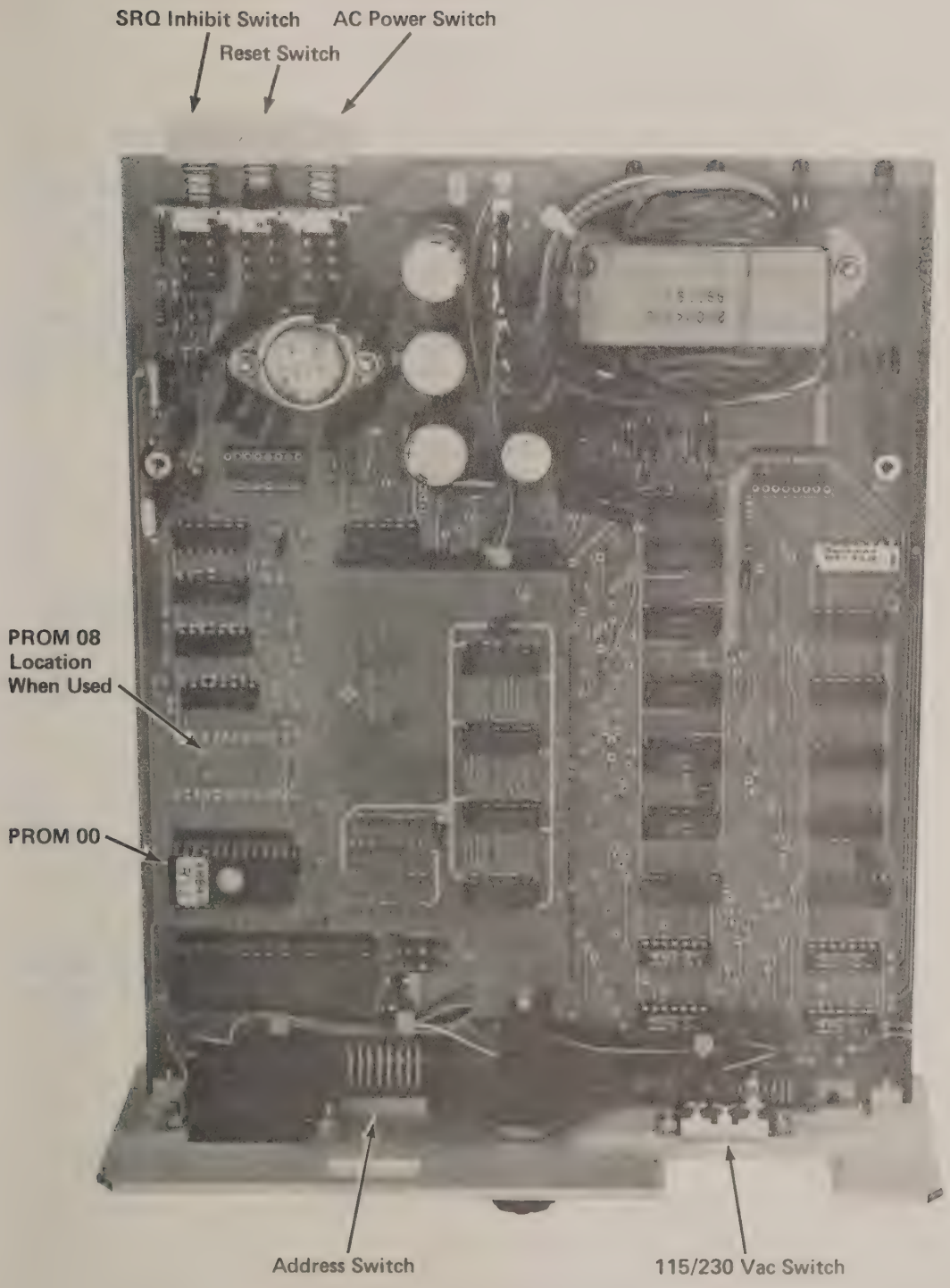


Figure 3-10 4884 Main Board Component Locations

3.4.2 PROM Program Tables

This section covers the 4884 PROM Program Tables that can be modified by the user to change the 4884's operation. All data is in hex code format, and each character has two hex digits (eight bits). Bit 1 (the LSB) is on the right. Logic '1' produces a high signal unless otherwise noted.

3.4.2.1 SECONDARY ADDRESS

The 4884 can be modified to use a secondary address by deleting the Parallel Poll Enable function. During the modification, the user selected secondary address is stored in the PROM. To modify the PROM, convert the following locations to the codes shown in the SA Code column.

TABLE 3-3 SECONDARY ADDRESS

Prom Address	PPE Code	SA Code	Description
00F9	02	10	Listen bit
0116	04	20	Talk bit
03C8	00	*	Secondary Address
03E5	5F	4D	Subroutine Address
03E6	03	02	

*The secondary address is coded into the five least significant bits as follows:

$$0 \quad 0 \quad 0 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$$

i.e. octal address 21 or hex code 11 is stored as 00010001.

3.4.2.2 EOM SENSE CHARACTER

The 4884 can be modified to detect a character other than the Carriage Return normally sensed to generate an SRQ, (see 1.2.6.3). To modify the PROM, replace the ASCII Carriage Return with any desired character as shown below.

TABLE 3-4 EOM CHARACTER

Prom Address	Standard Code	User Code	Description
03C7	OD		Carriage Return

3.5 PWB CHANGES

3.5.1 Parallel Poll Enable

The parallel poll response is disabled in all units as they leave the factory to make them compatible with early Tektronix 4051 Desktop Graphic Computers which accidentially activated the EOI line at all times. This condition has been corrected on all units produced after 1978 and/or on those with version 2 or later firmware. To enable the parallel poll response logic, relocate the EOI jumper so it bridges F to E, not + to E. This jumper is located on the top center portion of the main board. See Figure 3-7.

4

Theory of Operation

4.1 BLOCK DIAGRAM DESCRIPTION

4.1.1 Simplified Block Diagram

The 4884 RS-232 to IEEE 488 Bus Coupler block diagram is shown in Figure 4.1. The 4884 Coupler is a microprocessor based device that transfers data in a bidirectional fashion between RS-232 serial devices and the IEEE 488 Instrument Bus. Each 4884 Interface contains the 488 Bus Drivers-Receivers, Program Memory, RAM Memory, the Microprocessor and the Serial Interface. The Serial Interface provides both RS-232 and 20mA current loop signals.

4.1.2 Detailed Block Diagram

The 4884 RS-232 to IEEE 488 Coupler Detailed Block Diagram is shown in Figure 4-2. The Bus Driver-Receivers transfer data and command between the 16 line IEEE 488 Bus and the Coupler's internal 8 bit data Bus. In Listen state, the microprocessor temporarily stores the data from the IEEE Bus in the RAM output buffer area. Additional characters are loaded into the buffer until the Coupler is taken out of the Listen state. The microprocessor then transfers the first stored character to the UART. The UART converts the parallel 8-bit character into a serial character at the selected baud rate. The microprocessor transfers all of the remaining characters to the UART at the character transmission rate.

When the UART has received a serial character from an external source, it generates an interrupt to the microprocessor. The microprocessor senses the interrupt and stores the received character in the RAM data received buffer. If the Coupler is addressed as a Talker, the microprocessor transfers the character to the IEEE Bus. If not a Talker, the microprocessor checks the SRQ INHIBIT and EOM Switches to see if it can generate a Service Request by dropping the IEEE 488 SRQ line. Subsequent characters are either stored in RAM or put on the Bus depending upon the address state of the Coupler.

The RS-232 control signals are managed so as to handshake with those RS-232 devices capable of operating with the signals. Signals CC and CF are sensed to generate the RS-232 line ready signal. Request-to-send (CA) is raised and CB, CC and CF are checked prior to sending data out on BA. CB must be low before CA can be raised and must go high for the Coupler to serially output data. Data-Terminal-Ready (CD) is initially set high and dropped whenever the received data buffer becomes within 4 characters of being full. CD is raised again as soon as data is transferred onto the IEEE 488 Bus and the buffer has room for 8 or more characters.

The 488 Bus Interface operation is controlled by program commands stored in the PROM. The microprocessor follows these commands to transfer data, status and command functions between the 488 Bus and the serial device.

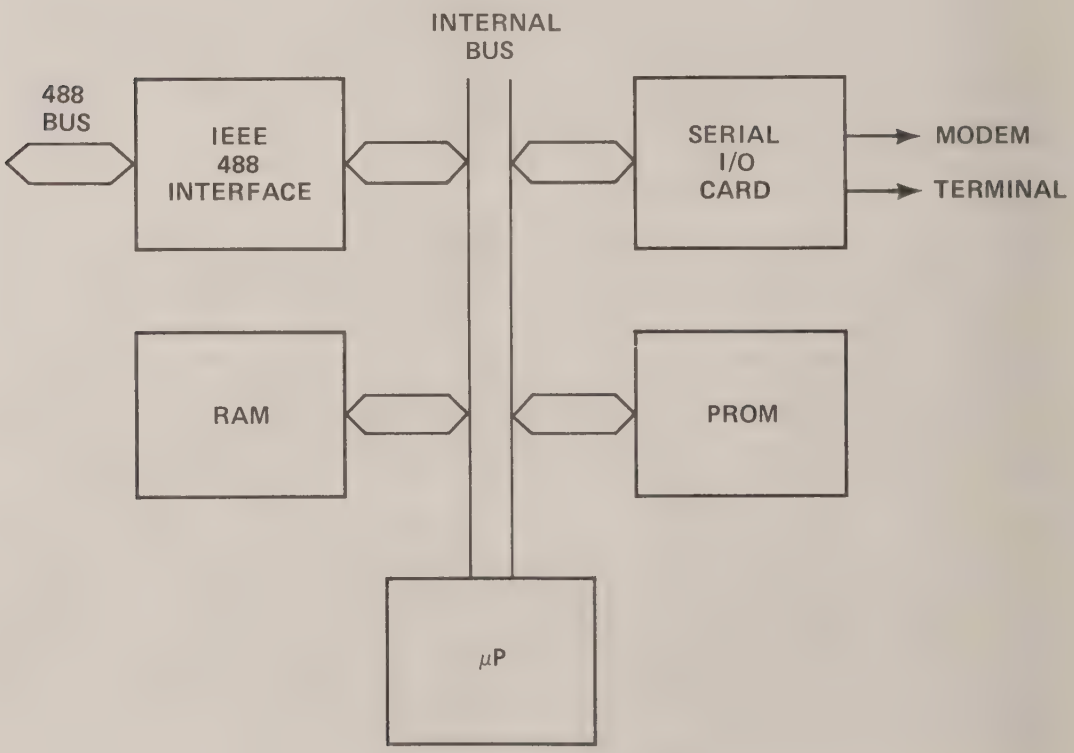


Figure 4-1 4884 Block Diagram

4.2 DETAILED LOGIC DESCRIPTION

4.2.1 **Main Board**(See Figure 7-1 sheets, 1, 2 and 3)

The two phase microprocessor (8080) clocks are generated by U11, which performs a divide-by-eight operation on the clock pulses from the oscillator U6 and crystal Y1. Memory addressing is accomplished by a 12 bit memory address bus. The lower eight bits directly address the memory byte; the upper four bits operate a decoder, U4, which selects the device being addressed. Data is transferred to the microprocessor on a bidirectional bus. Data bus drivers U9 and U10 are used to drive the output latches in the Bus and Output Logic sections. Capacitor C15 and resistor R9 are used to generate the power-on clear pulse. The IFC command, coupled on capacitor C19, also generates a reset pulse.

Flip-flop U40 senses the microprocessor's interrupt acknowedged status output on data line D0 during sync time. The flip-flop is then set for one clock time during which the flip-flop forces all inputs off on the bidirectional data bus, thereby generating the 8080's RST7 command. The 8080 microprocessor program counter jumps to location 0038 hex as a result of this command. Depending upon the state of the jumper in pad 1, interrupts come when the IEEE 488 ATN line goes low (I-A), or whenever the upper board has data ready (J-DR).

IEEE Bus Signals are terminated in resistor networks U24 and U32 before being gated onto the microprocessor data bus by gates U22,23,30 and 31. Bus output signals are stored in latches U25-28 before passing through the output drivers U33-36. Decoder U17 generates the latch load pulses and gate strobe pulses when the main decoder drops the AS7 line. Latch U18 is used to enable or disable the output drivers depending upon the state of the Bus E01 and ATN lines. Latch U18 can also be set under program control by raising data line D07 and generating strobe pulse 4 from decoder U17.

The 4884 power supply transformer can be switched to operate from 115 or 230Vac power by switch S4. Capacitor C1 filters the unregulated +22Vdc output. Regulator Q3 converts the unregulated voltage to +12 volts for the clock drivers. Regulator Q1 provides the +5 Vdc for all of the Coupler's TTL logic chips. Capacitor C4 filters the unregulated -15Vdc output. Regulator Q2 Converts the unregulated voltage to the -5Vdc microprocessor bias voltage.

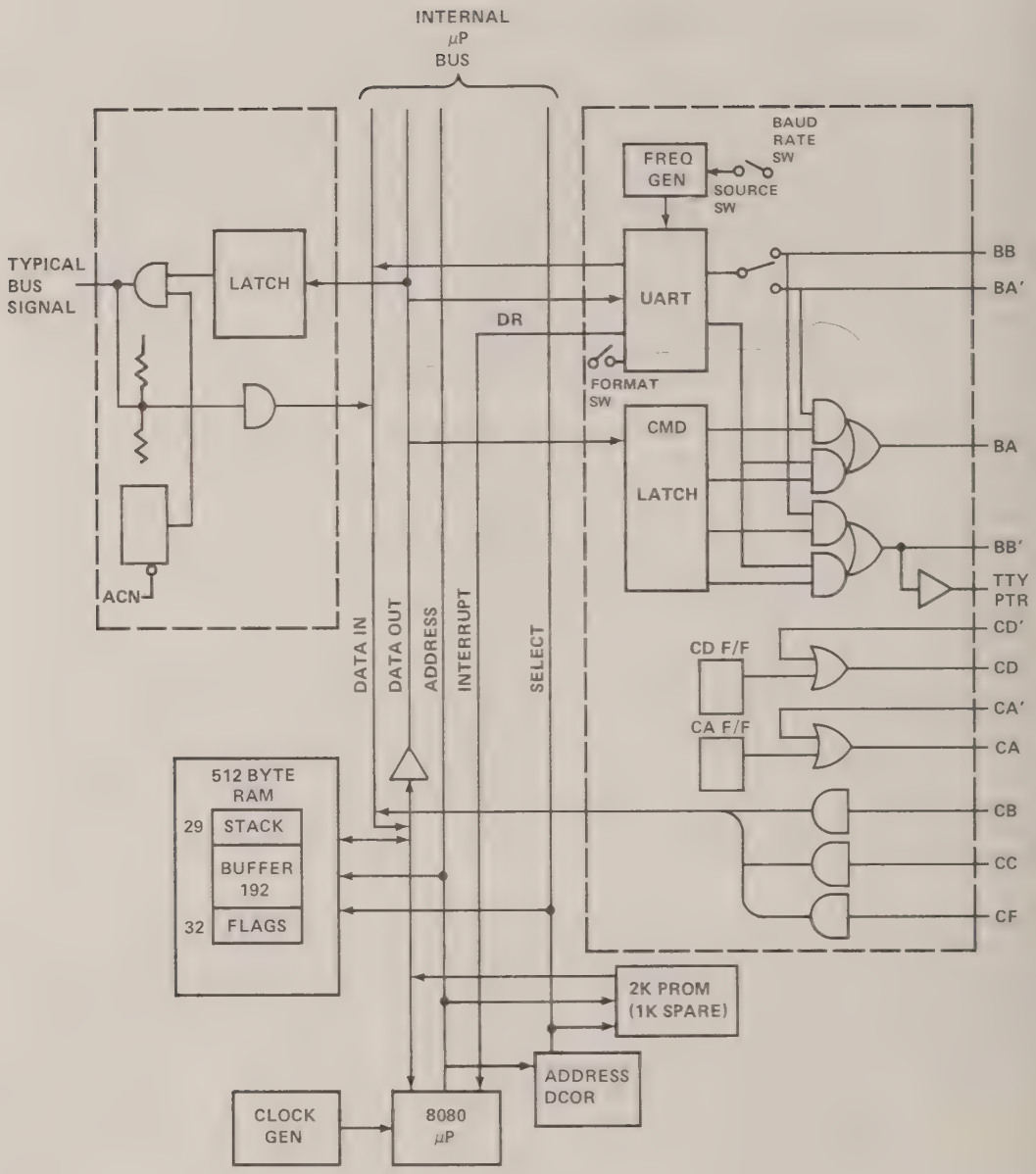


Figure 4-2 4884 Detailed Block Diagram

4.2.2 **Serial I/O Card** (See Figure 7-2)

This Serial I/O card contains the following major functions: power regulations, serial-to-parallel conversion, RS-232 interfaces, 20mA interfaces, and baud rate clock generation. Q3 and Q2 are three terminal regulators which provide -12V and +12V respectively to the UART, U18, and the RS-232 drivers. Power to the drivers is taken through diodes CR1 and CR2 to protect the drivers. The UART, U18, converts the serial input data into parallel form and parallel data into the output serial bit stream. When the UART has received a serial character it raises the DR signal which generates the negative interrupt, DR, through inverter U11. Address 0601 drops the DRR input, resetting the DR flag, and drops the RRD input which gates the received data (RR1-RR8) onto the microprocessor data bus. Address 0600 enables gates U14 and U17, which gates the UART's status signals onto the data bus. Output data is loaded into the UART by address 0601 which causes the THRL line to go low. All decoded address lines are enabled only during a write or data input time by the W/DBIN signal.

Baud rates are generated by selecting the proper rate from the ÷16 counter chips U9, U15 and U19. Switch B1 changes U9 to a ÷12 counter when open. Switch B2 changes U9 and U15 to be a 132 when open. Switches F3, F2, and F1 enter a 3-bit code into selector U3 to transmit the correct baud rate to the UART.

Quad receivers U1 and U4 convert the RS-232 serial data signals to TTL levels. Driver U5 converts levels and TTL serial data to +12V output levels. Transistor Q1 converts the serial voltage waveform into a 20mA current source to drive a 20mA teletype. The command latch, U13, is loaded by address 0605 and controls the gates which route the serial data to the RS-232 drives.

Optical isolator U21 converts a 20mA current into a negative true TTL level which is ORed into the received data line by OR gate UIO. Optical isolator U22 converts the negative true spacing level from U10 pin 8 into a saturated transistor output. The transistor appears as a floating open or closed switch to the computer TTY keyboard sensing circuit.

The CD latch U7 output is ORed with the terminal's CD signal by driver U5 to generate the output CD signal. CA latch U7 similarly generates CA which is ORed by driver U5 with the terminal's CA signal to generate the output CA signal. Gates U14 and U2 transfer the RS-232 signals, and EOM and S (spare) switch settings to the data bus upon receipt of address 0606.

5

Maintenance

5.1 INTRODUCTION

This section describes the maintenance and troubleshooting procedures for the Model 4884 Coupler. The 4884 Coupler does not require periodic calibration and has no internal adjustments. This section also includes a brief description of the 4884's logic convention and symbols.

5.2 REFERENCE DESIGNATIONS

The 4884 Bus Coupler is assembled in a one-half-rack-wide chassis with components mounted on circuit boards and the rear panels (see Figure 6-1). The circuit boards are mounted horizontally; the large bottom board is designated A1 and the other board is designated A2. Components on schematics and parts lists are designated by the partial reference designation; i.e.: Q1 rather than the complete form, A1Q1. Board component locations are shown in Figures 6-2 and 6-3.

5.3 TROUBLESHOOTING PROCEDURES

This section describes procedures for locating and correcting basic Coupler problems. It is assumed that the user has a good grasp of his overall system, some basic electronic knowledge and has read the Coupler's theory of operation in Section 4.1. Section 5.4 is a quick review of the more common digital logic symbols found on the Coupler's schematics.

Basic troubleshooting techniques vary depending upon whether this is an initial hookup or a failure in a working system. The following guide is to aid the user in solving initial turn-on problems.

1. Familiarize yourself with this 4884 by reading this manual.

2. Check RS-232 connections carefully. Use an oscilloscope to verify proper data flow and signal levels.

RS-232 Signal	Logic 1	Logic 0
Data	-5 to -25	+5 to +25
Control Signals	+5 to +25	-5 to -25

3. Check the current loop connections carefully. Use a VOM or oscilloscope to verify logic polarities. Plus signed 4884 signals must be more positive than the negative signal. Max open circuit voltage across J2 pins 23 and 25 cannot exceed 30 volts.

4. Use a Bus analyzer to verify Bus data. Check simple commands against Table 1-1 and look for necessary message delimiters; i.e.: LF for HP controllers, CR for Tektronix controllers.

5. Verify RS-232 handshaking signals' operations or fixed levels.

6. Verify baud rates and character formats.

Use the Fault Isolation steps in Table 5-1 to narrow down the problem to a specific area. The majority of simple problems can be fixed by following the table and making minor corrections to the system hookup or program. Occasionally there will be a hardware fault with the 4884. Call ICS for assistance or an RMA number before returning the unit to ICS for repair. If you are repairing the unit yourself, consult the spare parts list or Coupler parts lists in Section 6.1 for correct part numbers and description when ordering any module, assembly, or other replacement part.

The 4884 can perform self-diagnostic testing by the use of the 112051 Test PROM Kit. The Test PROM Kit replaces the 4884 Coupler PROM with another PROM programmed to check out each section of the Coupler. The serial I/O Board is tested by plugging the wrap-around connector (included with the kit) into J2. Test pass, fail, and fault information is displayed on the front panel indicators. Refer to the instructions included in the Test PROM Kit for step-by-step checkout instructions.

WARNING

IF THE FAULT ISOLATION PROCEDURE REQUIRES INTERNAL MEASUREMENTS, ALWAYS REMOVE POWER WHEN DISASSEMBLING OR ASSEMBLING THE UNIT. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENTS, OR REPAIR TO PREVENT SHORTING COMPONENTS AND FURTHER DAMAGE TO THE UNIT.

TABLE 5-1 MODEL 4884 FAULT ISOLATION STEPS

Symptom	Possible Fault	Check
No power or no POWER light	Blown fuse	Fuse on rear panel
	115/230V Switch	Switch on rear panel
	AC power	Power cord plugged into rear panel and AC outlet
	Broken LED	Check LED, CR8
No lights	+5Vdc power	CR3,4 and Q1
	Broken LED	Check LED, CR8
READY light OFF	RS-232 status lines low	CC and CF inputs
	Microprocessor miss-start	Press RESET or turn POWER off for 10 seconds
	Loose part after shipment	PROMs, microprocessor, cable connectors, and any socket mounted part
No TALKING or LISTENING light response	Wrong Address	Address switch setting
		Value in controller program

TABLE 5-1 MODEL 4884 FAULT ISOLATION STEPS - Continued

Symptom	Possible Fault	Check
No TALKING or LISTENING light response	Wrong Address	Single or extended address only if PROM changed
	Reset not pressed after changing T, L, or O switches	Press RESET
TALKING light on	T and O switches on	Address switch
	Untalk or listen address not sent	Controller program
	No data received	Imput device
	Controller has not received Terminating character	Check imput device: HP9825 needs a line feed. Tektronix 4051 needs a carriage return.
TALKING light off	L and O switches on	Address switch
	Wrong address	Address switch setting (3.1.2)
		Controller program
LISTENING light on	L and O switches on	Address switch
	Unlisten or talk address not sent	Controller program
LISTENING light off	T and O switches on	Address switch
	Wrong address	Address switch setting (3.1.2)
		Controller program

TABLE 5-1 MODEL 4884 FAULT ISOLATION STEPS - Continued

Symptom	Possible Fault	Check
No data when addressed to Talk	Not in Talk mode	See TALKING above
	Serial data not received	Source switch setting
		Data input signals on correct pins
		Wrong baud rate setting
	Controller terminating character not passed on to controller	Characters sent to 4884 and characters transferred to Bus controller
No serial data output	No output data received	Never in Listen Mode See LISTENING above
	CB Missing	RS-232 Device actually acknowledges CA with CB
		CB jumpered to CA
	Device missing data	Wrong baud rate
	4884 left in Listen	LISTEN light and controller program for UNL command
Unwanted SRQ's	SRQ INHIBIT Switch out	SRQ INHIBIT Switch position
	EOM switch off	EOM switch position
	Noise or data on RS-232 line	RS-232 device and line connections

TABLE 5-1 MODEL 4884 FAULT ISOLATION STEPS - Continued

Symptom	Possible Fault	Check
No SRQ's on received messages	EOM character not sensed	Received character code doesn't match OD (hex)
		Parity bit setting mismatch between 4884 and RS232 device
No response to Parallel Poll	ATN not raised after sending PPE command	Controller program
	ATN off delay too short	Controller program
Garbled Data	Character format wrong	Character format switch setting so logic 1 is toward U18 (UART)
	Baud rate setting wrong	Baud rate switch setting

5.4 LOGIC CONVENTIONS

The unit used positive logic, which means the normally active or high signal state is +2.4 to +5 volts and the inactive or low state is 0 ±0.5 volt. The high state is referred to as logic 1 and the low state is logic 0. The terms true and false relate to the signal being in or out of its active state and normally correspond to logic 1 and 0. However, for some signals such as the input of a OR gate, the true or active state is the low signal level (0 volts).

Complements of signals are indicated by an F or N suffix or by an inversion dot on the logic symbol. Complemented signals are always low when the original signal is high and vice versa. See Figure 5-1 for the standard logic symbols.

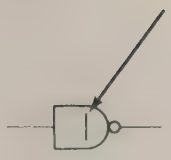
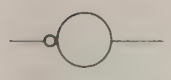
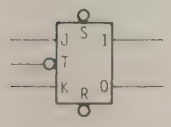
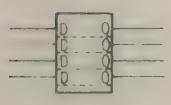
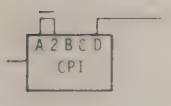
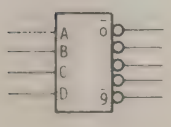
Symbol	Function	Description
o	Inversion Dot	Part of a larger symbol. Indictes that the input or output signal is low when in the active or true state.
	Open collector bar	Bar on output indicates an open collector device without an internal signal pullup.
	NAND gate	Performs the positive NOT-AND function. Output is low when all inputs are high.
	NOR gate	Performs the negative NOT-OR function. Output is high when one or more inputs are low.
	Wired OR	Performs an OR function using only chassis wires. Output low when one or more inputs are low.
	Amplifier, (level shifter or inverter)	Performs signal current amplification or level shift function. Signal polarities shown by inversion dots.
	Inverter	Performs a logic signal inversion; always used with the inversion dot.
	Clocked Flip-Flop	Output changes state on negative edge of clock if J and/or K was true during clock time. Outputs set or reset if either Preset or Reset input grounded.
	Quad Latch	Four D or storage flip-flops in single package. Normally has both Q and $\overline{Q}$ outputs. Data loads while clock high, latched when low.
	Counter	Four cascaded flip-flops in a single package designed as a counter. Divides by 10, 12, or 16. Check an IC catalog for reset, clear and load signal definitions.
	Decoder	Four line BCD to ten line decimal decoder. Outputs low when active.

Figure 5-1 Standard Logic Symbols

6

Parts List and Location

6.1 INTRODUCTION

This section contains all information necessary to locate, identify, and order parts. The listing of parts and information for an exact replacement are shown in the attached parts list. All component locations are identified by reference designators in the parts list and in the attached circuit board assembly drawings. Layouts for the unit's circuit boards are shown in Figures 6-2 thru 6-4.

6.2 REPLACEMENT PARTS

6.2.1 Standard Parts

All parts can be purchased directly from ICS Electronics Corporation at current market price, plus a handling charge. However, since most parts are standard electronic components, it is suggested that they be secured locally for prompt replacement. The parts list gives all pertinent information including the recommended manufacturers. Where not noted, equivalent parts meeting the original part specifications may be substituted. A list of manufacturers by abbreviations is given in Table 6-1; and recommended spare parts in Table 6-2.

6.2.2 Special Parts

Parts marked with a Data Works, Fairchild Instrumentation, or ICS part number should be procured directly from ICS Electronics Corporation. These parts are manufactured or selected to satisfy specific requirements. Substitution of other parts might not yield equivalent performance and will void any warranty.

6.2.3 Parts Ordering Information

All orders should be directed to ICS Electronics Corporation at the address shown on the front page, or to ICS Electronics in care of your local representative. When ordering, be sure to include the following information:

a. Part description and reference designator
b. Part number, manufacturer, and stock number
c. Instrument model, serial number, and program revision level.

TABLE 6-1 List of Manufacturers by Abbreviations

Abbreviations	Company
ABC	Allen Bradley, Milwaukee, WI
ACT	Advanced Components Technology, Inc., Redwood City, CA
ACW	Alpha - CW, Elizabeth, NJ
AD	Analog Devices, Norwood, MA
AEP	Alco Electronic Products, Inc., Lawrence, MA
AMA	Amatom, New Haven, CT
AMD	Advanced MicroDevices, Sunnyvale, CA
AMP	Amp Incorporated, Harrisburg, PA
AMR	American Relays Inc., Gardena, CA
APH	Amphenol Corporation, Oakbrook, IL
APL	Amplicon, Brighton, GB
ARC	Arco, Commack, NY
ARI	Aries Industries, Inc., Gardena, CA
AUG	Augat Inc., Attleboro, MA
AVD	Aavid Eng., Inc., Laconia, NH
BEC	Beckman, Heliport Division, Fullerton, CA
BEL	Belden Corp., Richmond, VA
BOR	Bourns, Riverside, CA
BRG	Berg Electronics, New Cumberland, PA
BUD	Budwig, Los Angeles, CA
BUS	Bussmann, Earth City, MO
BUR	Burndy, Norwalk, CT
BVR	Bivar, Santa Ana, CA
C & K	C & K Components Inc., Newton, MA
CAC	Circuit Assembly Corporation, Costa Mesa, CA
CAN	Cannon, Santa Ana, CA
CEL	Cellotape, Sunnyvale, CA
CHR	Cuttler Hammer, Milwaukee, WI
CHY	Cherry Electrical Products Corp., Highland Park, IL
CJO	Cinch Manufacturing Co., Elk Grove Village, IL
CMS	Component Manufacturing Service, Bridgewater, MA
CDE	Cornell Dublier, Newark, NJ
CNT	Centralab, Los Angeles, CA
COR	Corcom Inc., Chicago, IL
CRN	Corning Glass Works, Corning, NY
CRZ	Crazy Glue, Chicago, IL
CTS	CTS Corporation, Elkhart, IN
DAL	Dale Electronics Incorporation, Columbus, NB
DIA	Dialco, Brooklyn, NY
DWI	Data Works Instrumentation, (See ICS)

TABLE 6-1 List of Manufacturers by Abbreviations - Continued

Abbreviations	Company
EDC	EDAC Inc., Don Mills, Ontario Canada
ELL	Elec-Trol, Saugus, CA
EMC	Electronic Molding Corp., Woonsocket, RI
EPI	Epitek, Kanta, Ontario, Canada
ERI	Erie Technological Products, Erie, PA
EXL	Excel, Chicago, IL
FCL	Freedom Crystal Lab, Freedom, CA
FIS	Fairchild Inst. & Controls Div., (See ICS)
FLK	Fluke, Santa Clara, CA
FSC	Fairchild Semiconductor Div., Mountain View, CA
GCE	GC Electronics, Rockford, IL
GHI	Grayhill, La Grange, IL
GEN	GenRad, Concord, MA
GOR	Gordos Corporation, Bloomfield, NJ
HAM	Hamlin Relays, Lake Mills, WI
HEY	Heyboer, Grand Haven, MI
HHS	Herman H. Smith, Inc., Brooklyn, NY
HP	Hewlett-Packard, Palo Alto, CA
HIT	Hitachi, Tokyo, Japan
ICS	ICS Electronics Corporation, San Jose, CA
IER	International Electronics Research Corporation, Burbank, CA
INL	Intel, Sunnyvale, CA
INT	Intervor, Melville, NY
IRC	TRW/IRC Resistors, Philadelphia, PA
ITT	ITT General Controls, Glendale, CA
JAR	Jarome Wire, Mountain View, CA
JFR	Jeffers Electronics, Nogales, AZ
KEM	Kemet, Greenville, SC
KOS	Koszeigi, South Bend, IN
LFS	Little Fuse Inc., Des Plaines, IL
LOP	Zollin J. Lopaugh, San Francisco, CA
LYN	Lyntron, Inc., Burbank, CA
MMM	3M, Minneapolis, MN
MED	Meadows Manufacturing, Sunnyvale, CA
MIN	Minicomputer Accessories, Sunnyvale, CA
MLX	Molex Products Co., Downers Grove, IL

TABLE 6-1 List of Manufacturers by Abbreviations (Continued)

Abbreviations	Company
MON	Monsanto, Palo Alto, CA
MOT	Motorola Semiconductor Products, Inc., Phoenix, AZ
MSC	Master Specialities Co., Costa Mesa, CA
NAT	National Semiconductor Ltd., Plattsburgh, NY
NIC	Nichicon, Chicago, IL
NSC	Nor-Cal Seal Co., San Leandro, CA
NYM	Nymph (SaRonix), Palo Alto, CA
PAN	Panduit, Tinley Park, IL
PCL	Precision Crystal Lab, Santa Monica, CA
PMI	Precision Monolithics Inc., Santa Clara, CA
PNS	Panasonic, Secaucus, NJ
PTS	Promptus Electronic Hardware, Lomita, CA
RAY	Raytheon, Mountain View, CA
RCH	Richlock, Chicago, IL
RGA	RG Allen, Van Nuys, CA
RNU	Robinson Nugent, New Albany, IN
SAE	Stanford Applied Engineering, Long Beach, CA
SCN	Scanbe, El Monte, CA
SEK	Seiko Circuits, Sunnyvale, CA
SGS	Silicon General, Westminister, CA
SHO	Shoin, Japan
SIG	Signetics Corp., Sunnyvale, CA
SIL	Siliconix, Inc., Santa Clara, CA
SMN	Seimens, Iselin, NJ
SMT	Samtec, New Albany, In
SOU	Souriau Inc., Van Nuys, CA
SPC	Spectra Strip, Garden Grove, CA
SPR	Sprague Electronics, Chicago, IL
SWC	Switchcraft, Inc., Chicago, IL
TBA	T & B Ansley, Los Angeles, CA
TEK	Tektronics, Inc., Beaverton, OR
TEM	Temple Industries, Inc., Tecate, CA
TEX	Textool, Irving, TX
THC	Thermalloy Co., Dallas, TX
TI	Texas Instruments, Semiconductor Div., Dallas, TX
TRW	TRW Capacitors, Ogallala, NE
UCC	United ChemCom, Rosemont, IL
USE	USECO, Van Nuys, CA

TABLE 6-1 List of Manufacturers by Abbreviations - Continued

Abbreviations	Company
VEM	Vemaline, Warwick, RI
VIK	Viking, Chatsworth, CA
WDC	Western Digital Corp., Newport Beach, CA
WEK	Weckesser, Chicago, IL
WFD	Wakefield Engineering, Inc., Wakefield, MA
WIN	Winchester, Oakville, CT
WLD	Waldom, Chicago, IL
WMA	WIMA (distributed by TAW, Inc., Burbank, CA)
ZIL	Zilog, Inc., Cupertino, CA

6.3 PARTS LIST

The parts list (Table 6-3) contains all components and sub-assemblies that make up the unit. Subsequent Tables 6-4 and 6-5 break the main board assembly (A1) down to the component level. Table 6-6 breaks the I/O Board Assembly (A2) down to the component level. Table 6-7 covers the Memory Expansion Module (A-3).

The parts list tables contain both the ICS Electronics Corporation stock numbers and the manufacturers' true part numbers where applicable. True manufacturers' part numbers are not shown for industry standard parts nor items unique to the 4884 Coupler.

TABLE 6-2 4884/5A RECOMMENDED SPARE PARTS LIST

For assembly level sparing order the following: Item 1 or 2, Item 3, 4, and Item 5A or 5B.

For component level sparing, items 5 through 42 may be ordered separately or together in kit form as 4884/5 Spare Parts Kit, P/N 111253, (see item 44). Refer to Stock Number when ordering from ICS Electronics.

Item	Qty.	Mfgr.	Part Number	Description	Stock No.
1	1	ICS	97477812	Assy. Main Board	112202
2	1	ICS	97474805	Assy. Main Board Less Rear Panel	112204
3	1	ICS	97474806	Assy., Serial I/O Card	112206
4	1	ICS	12096	Assy., Memory Exp.	112096
5A	5	LFS	313001	Fuse 3AG 1 Amp	900002
5B	5	LFS	313000.5	Fuse 3AG 1/2 Amp	900001
6	1	ICS	20004190	Transformer	125000
7	1	GHI	76B08	Switch, Rocker & Posn.	907011
8	1	ICS	05902542	Switch 3 Posn.	907013
9	1	FSC	UA7805	Regulator +5V	730340
10	1	FSC	UA7905	Regulator -5V	737905
11	1	FSC	UA7812	Regulator +12V	737812
12	2		IN4001	Diode, 50V, 1A	714001
13	2	MOT	MR 502	Diode, 200V, 3A	710502
14	2	FSC	FLV160	LED, RED	710160
15	1	ICS	27903010	Crystal 14.7 MHz	904001
16	1	AMD	8080A	Microprocessor	798080
17	1	ICS	2708	PROM, with 4884 Program	792708
18	1	AMD	74LS138	IC, DCDR	742138
19	1		74LS13	IC,Schmitt Trig.	742013
20	1		74LS04	IC, Hex Inv.	742004
21	1	AMD	2112A-04	RAM 4 x 256	792112
22	1	SIG	8T97	IC, DVR	738097
23	1		74LS197	IC ÷ 16	742197
24	1		74LS00	IC, QUAD NAND	742000
25	2		74LS03	IC, QUAD NAND	742003
26	1		74LS74	IC, D F/F	742074
27	1		74LS10	IC, 3 INput NAND	742010

*See ICS's latest 4884/5 Recommended Spare Parts list for current prices.

TABLE 6-2 4884/5 RECOMMENDED SPARE PARTS LIST
(Continued)

Item	Qty.	Mfgr.	Part Number	Description	Stock No.
28	1		7406	IC, Hex DVR	740006
29	2		74LS75	IC, QUAD Latch	742075
30	1		7438	IC, DVR	740038
31	1		74107	IC, JK F/F	742107
32	1	ABC	316E302622	RES. NET 3K/6.2K	697002
33	1	DAL	898-1-R3.3K	RES. NET 3.3K	697001
34	1		2N3906	Transistor, PNP	723906
35	1	FSC	UA7912	Regulator, -12V	737912
36	1	GHI	76B05	Switch, Rocker, 5 Posn.	907010
37	1	MOT	1489P	IC, RS-232 Rcvr.	731489
38	1		74125	IC, Tristate Buffer	740125
39	1		74151	IC, MUX	742151
40	1	MOT	1488P	IC, RS-232 DVR	731488
41	1		74LS93	IC, ÷16 CTR	742093
42	1		74LS08	IC, QUAD AND	742008
43	1	WDC	TR1863B	IC, UART	791863
44	1	ICS	-	4884 Spare Parts Kit (includes items 5A, 5B)	111253

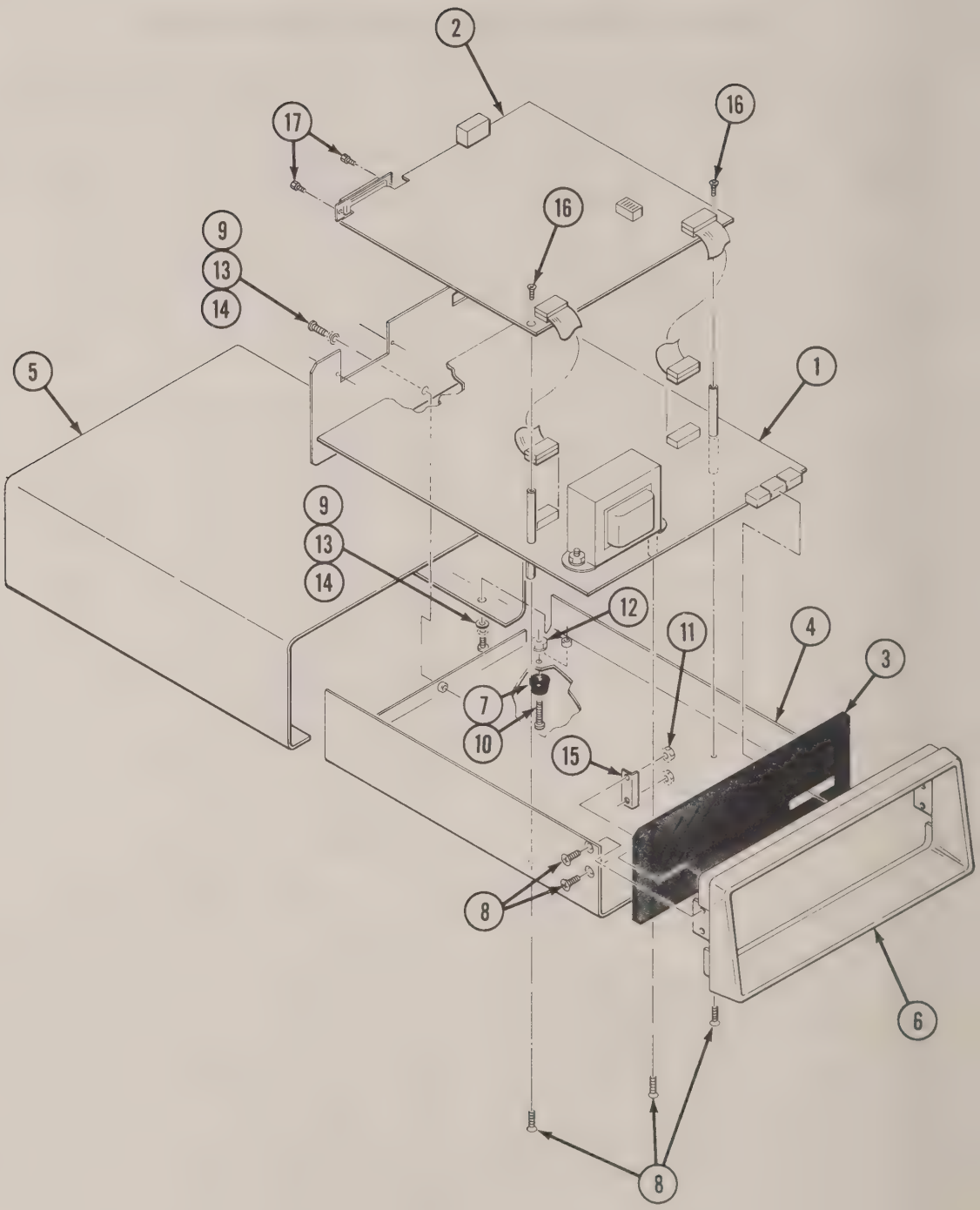


Figure 6-1 4884 Coupler Exploded Assembly

TABLE 6-3 4884 RS-232 COUPLER - PARTS LIST, P/N 112200

Identification No.	Stock Number	Qty. Per Assem.	Description	Ref.	Mfgr.	Mfgr.P/N
1	112202	01	ASSY MAIN BOARD	A1		
2	112206	01	ASSY, RS-232 I/O BOARD	A2		
3	112033	01	FRONT PANEL			
4	112237	01	BASE PLATE			
5	112238	01	COVER			
6	112239	01	BEZEL			
7	908000	04	FOOT, MTG			
8	412603	08	SCREW, #6-32 x 3/8 FH			
9	411803	05	SCREW, #8-32 x 3/8 PH			
10	411404	04	SCREW, #4-40 x 1/2 PH			
11	422600	04	KEPNUT, #6			
12	422400	04	KEPNUT, #4			
13	431800	05	WASHER, SPLIT-LOCK, #8			
14	430800	05	WASHER, FLAT, #8			
15	112258	02	CLIP, RETAINING			
16	411603	02	SCREW, 6 X 32 X 3/8, PH			
17	490005	02	STUD, FEMALE LOCKING	(J2)	CJO	BD-20418-2
18	112096	01	ASSY, MEMORY EXP. MODULE	A3		
19	112001	01	LABEL			

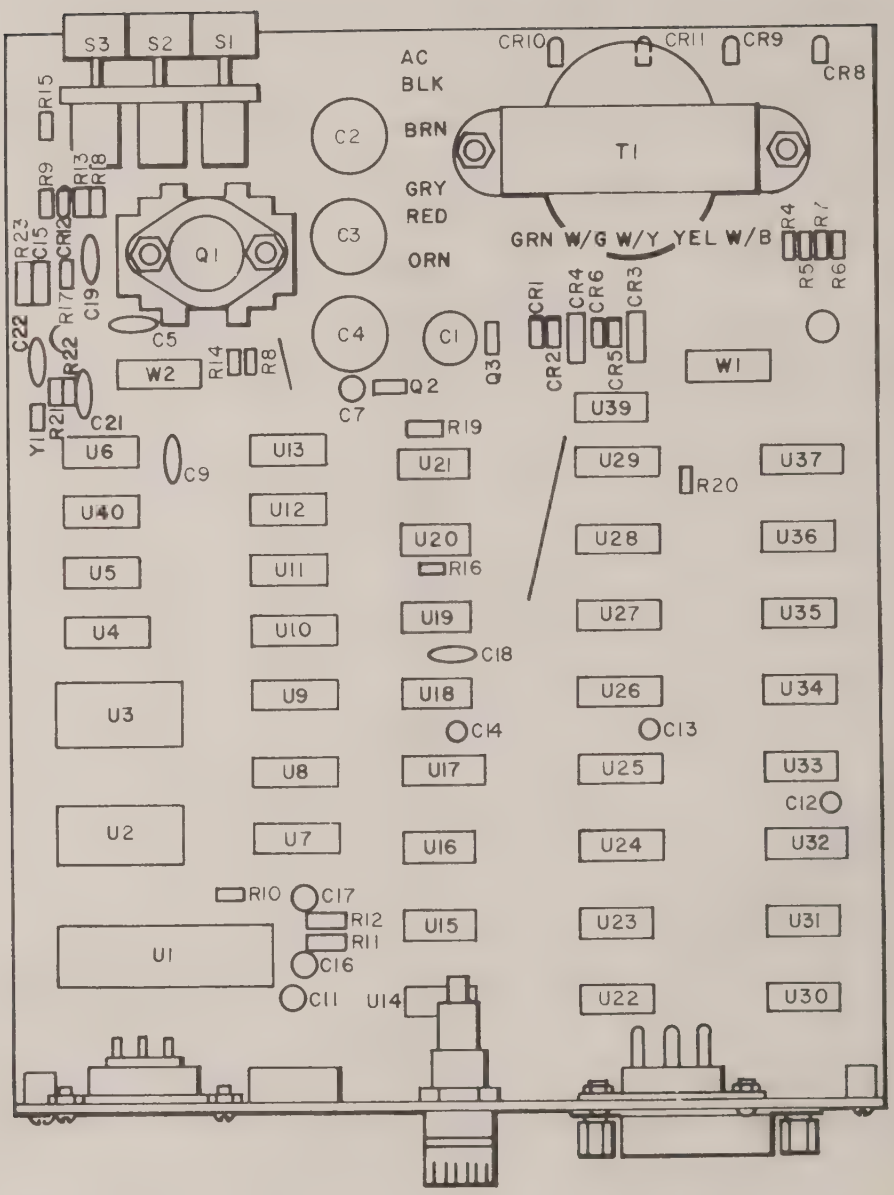


Figure 6-2 Assembly 4884 Main Board

TABLE 6-4 4884 MAIN BOARD PARTS LIST, P/N 112202

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
907012	01	SWITCH, SLIDE 115/230VAC	S4		
902009	01	RECEPTABLE, AC, POWER	J4		
-	01	CABLE, HARNESS			
411404	04	SCREW 4-40 x 1/2 PH, PHL	(S4), (J4)		
421400	04	NUT #4 SMALL PATTERN	(S4), (J4)		
431400	04	LOCKWASHER #4	(S4), (J4)		
112036	01	REAR PANEL			
112204	01	4880 ASSY-PCB			
900002	01	FUSE, 3AG, 1 AMP	F1	LFS	313001
901001	01	FUSEHOLDER, 3AG	XF1	LFS	342004
490001	02	MTG STUD, STANDOFF, (M)	(J1)	ICS	0380-0643

TABLE 6-5 PC BOARD ASSEMBLY PARTS LIST, P/N 112204

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
111004	01	P.C. BOARD			
905003	01	TRANSFORMER, 10079	T1		
907013	01	SWITCH ASSY, 3 POSN	S1-3		
907011	01	SWITCH, ROCKER, 8 POSN	S5	GHI	76B08
903005	01	SOCKET, 16 PIN, RT ANGLE	(S5)	AUG	516-AG7D
902004	01	CONNECTOR, 24 PIN	J1	APH	57-20240-2
906001	01	HEATSINK	(Q1)	IER	LAT03B5CB
730340	01	REG., UA7805, POS, +5V	Q1		
737905	01	REG., UA7905, NEG, -5V	Q2		
737812	01	REG., UA7812, POS, +12V	Q3		

TABLE 6-5 PC BOARD ASSEMBLY PARTS LIST, P/N 112204
(Continued)

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
714001	05	DIODE, IN4001, 50V, 1A	CR1,2,5,6		
710502	02	RCTFR, MR502, 200V,3A	CR3,4	MOT	
710160	04	LED, RED	CR8-11	FSC	FLV160
904001	01	CRYSTAL, 14.745 MHz, PC 18	Y1		
564207	01	CAP, ELEC, 200UF, 35V	C1	TEM	411-200-35
562152	03	CAP, ELEC, 1500UF, 15V	C2-4	TEM	411-1500-15
535104	03	CAP, CERAMIC, 0.1UF, 50V	C5,9,10	ERI	8121-050-L51-104M
520475	05	CAP, TANT, 4.7UF, 10V	C7, 11-14	ITT	TAG F20 4.7-10 CSR13 C276KL
510027	01	CAP, TANT, 27UF, 35V	C15		
520106	02	CAP, TANT, 10UF, 16V	C16,17	ITT	TAG F20 10-16
559102	01	CAP, DISK, .001 UF	C18	ERI	831-000-YSFO-102X
553103	01	CAP, DISK, .01 UF	C19	ERI	5835-000-Y5U0-103E
524105	00	CAP, TANT, 1.0 UF, 35V	C20	ITT	TAG F20 10-35
548240	02	CAP., 24 PF, 500V	C21, C22		
602222	03	RES, 2.2K, 1/4W 5%	R21-22,16		RC07GF222J
602161	05	RES, 160 , 1/4W 5%	R4-7,17		RC07GF161J
602333	06	RES, 33K, 1/4W 5%	R8,9,10,14 15,19		RC07GF333J
603331	02	RES, 330 , 1/2W 5%	R11,12		RC07GF104J
602104	02	RES, 100K, 1/4W 5%	R13		RC07GF104J
602224	01	RES, 220K, 1/4W 5%	R18		RC07GF224J

TABLE 6-5 PC BOARD ASSEMBLY PARTS LIST, P/N 112204
(Continued)

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
602103	01	RES, 10K, 1/4W 5%	R20		RC07GF103J
798080	01	9080A/P8080A	U1	AMD	
792708	01	2708	U2	ICS	
742138	02	74LS138	U4, U17	AMD	
742013	01	74LS13N	U5		
742004	02	74LS04N	U6, U16		
738097	02	8T97	U9, U10	SIG	
742197	01	74LS197N/9LS197N	U11		
742002	02	74LS02N/9LS02	U13, U19		
742003	06	74LS03N/9LS03N	U14-15, U22-23, U30-31		
741074	01	74S74N/9S74N	U18		
742010	02	74LS10N/9LS10N	U20, U12		
740006	01	7406N	U21		
697002	02	RES, NET, 3.3K, 6.2K	U24, U32	ABC	316E302622
742075	05	74LS75N/9LS75N	U25-29		
740038	05	7438N	U33-36, U39		
697001	01	RES, NET, 3.3K	U37	DAL	898-1-R3.3K
742107	01	74LS107N/9LS107N	U40		
441607	04	SPACER, MALE-FEMALE	(T1)		
422600	04	KEPNUT #6	(T1) (Q1)		
430800	04	WASHER, FLT. #8	(T1) (Q1)		
411604	04	SCREW, 6 X 32 X 1/2, PH,PHL			
903006	04	SOCKET, 16 PIN	(U7, 8) (W1, 2)		
903007	02	SOCKET, 24 PIN	(U2, 3)		
903008	01	SOCKET, 40 PIN	(U1)		
442612	02	STANDOFF, SWG, 1-1/2 X 6-32	NONE	LYN	L6910-24-3C
490003	02	CHASSIS, FASTENERS	NONE	USE	1590C11

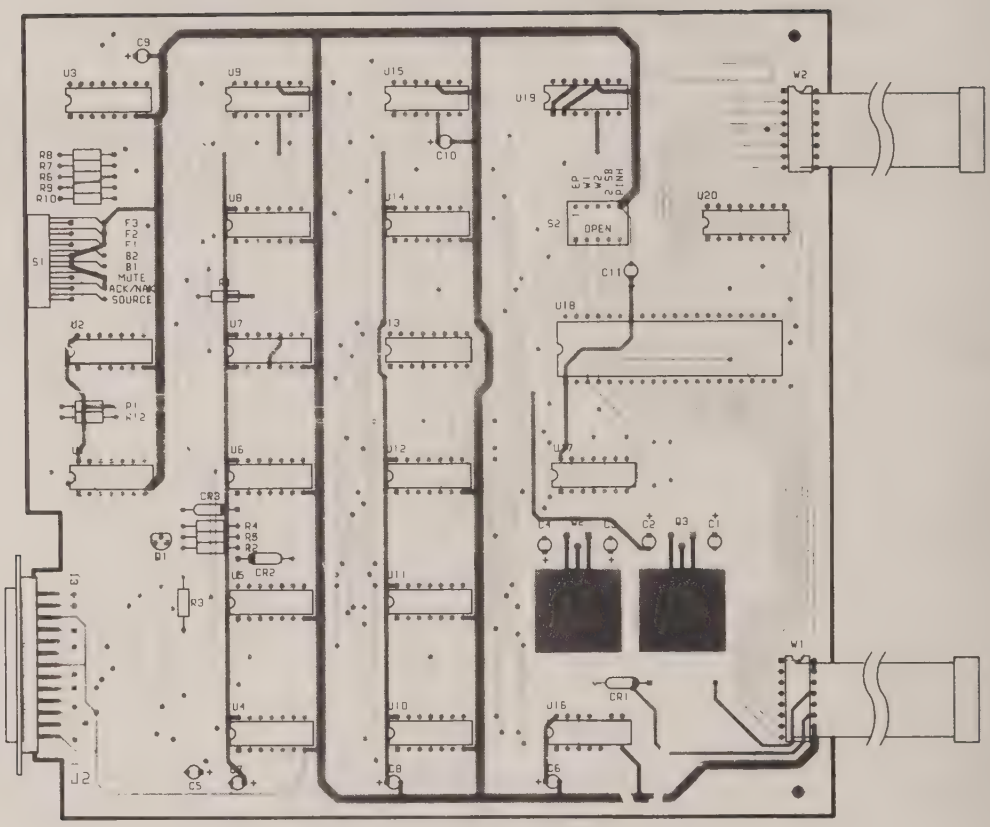


Figure 6-3 Assembly 4884 RS-232 I/O Card

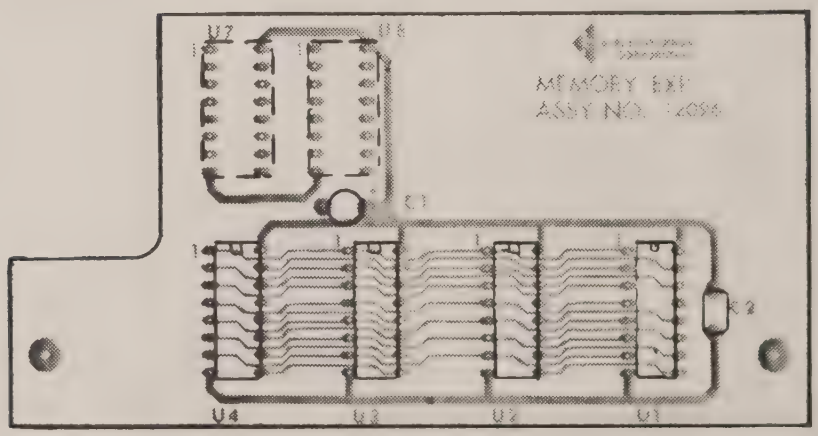


Figure 6-4 Assembly, Memory Expansion Module

TABLE 6-6 4884 SERIAL I/O CARD - PARTS LIST, P/N 112206

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
122208	01	P.C. BOARD			
524105	04	CAP, TANT, 1 UF, 35V	C1,2,3,4	ITT	TAG F20 1.09-35
524474	01	CAP, TANT, .47 UF, 35V	C5	ITT	TAG F20 0.47-35
524751	06	CAP, TANT 4.7 UF, 10V	C6-11	ITT	TAG F20 4.7-10
714001	03	DIODE, IN4001	CR1, 2, 3		
602273	01	RESISTOR, 27K, 1/4W, 5%	R2		RC07GF273J
602103	01	RESISTOR, 10K, 1/4W, 5%	R3		RC07GF103J
602152	01	RESISTOR, 1.5K, 1/4W, 5%	R4		RC07GF152J
602101	01	RESISTOR, 100 , 1/4W, 5%	R5		RC07GF101J
602333	08	RESISTOR, 33K, 1/4W, 5%	R1, R60 R12		RC07GF333J
723906	01	TRANSISTOR, PNP, 2N3906	Q1		
737812	01	REG., +12V	Q2	FSC	UA7812
737912	01	REG., -12V	Q3	FSC	UA7912
902000	01	CONNECTOR, 25 SOCKET	J2	CJO	DB-25S
110103	02	CABLES, FLAT RIBBON, 16 CONN	W1,W2		
907011	01	SWITCH, ROCKER 8 PST	S1	GH1	76B08
907010	01	SWITCH, ROCKER 5 PST	S2	GH1	76B05
903005	01	SOCKET, 16 PIN RT. ANGLE	(S1)	AUG	516-AG7D
903008	01	SOCKET, 40 PIN	(U18)		
-	02	RS-232 RCVR, 1489P	U1, U4	MOT	

TABLE 6-6 4884 SERIAL I/O CARD - PARTS LIST, P/N 112206
(Continued)

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
740125	03	74125	U2,U14,U17		
742151	01	74LS138	U3	AMD	
731489	01	RS-232 DVR, 1488P	U5	MOT	
742093	03	74LS93/9LS93	U9,U15,U19		
742008	01	74LS08/9LS08	U8		
742000	04	74LS00/9LS00	U6,U10,U12 U16		
742004	01	74LS04/9LS04	U11		
742075	01	74LS75/9LS75	U13		
742074	01	74LS74/9LS74	U7		
791863	01	UART, 1863B	U18		
742138	01	74LS138/138	U20		

TABLE 6-7 4880 MEMORY EXPANSION MODULE - PARTS LIST, P/N 112096

Stock Number	Qty. Per Assem.	Description	Reference	Mfgr.	Mfgr.P/N
112098	01	PCB	-	-	-
520475	01	CAP, TANT, 4.7UF, 10V	C1	ITT	TAG-F20-4.7/10-50
553103	01	CAP, DISK, .01UF, 35V	C2	ERI	
792112	04	RAM, 256 x 4	U1-U4	INL	2112-4

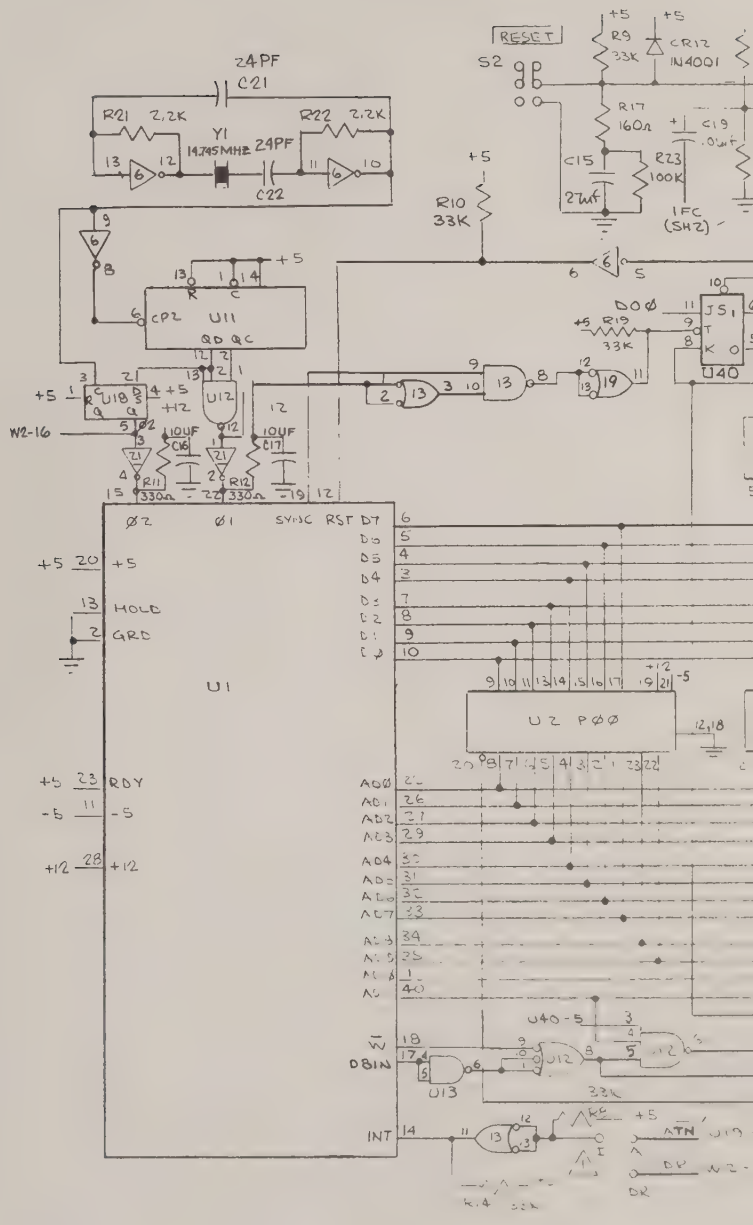
7

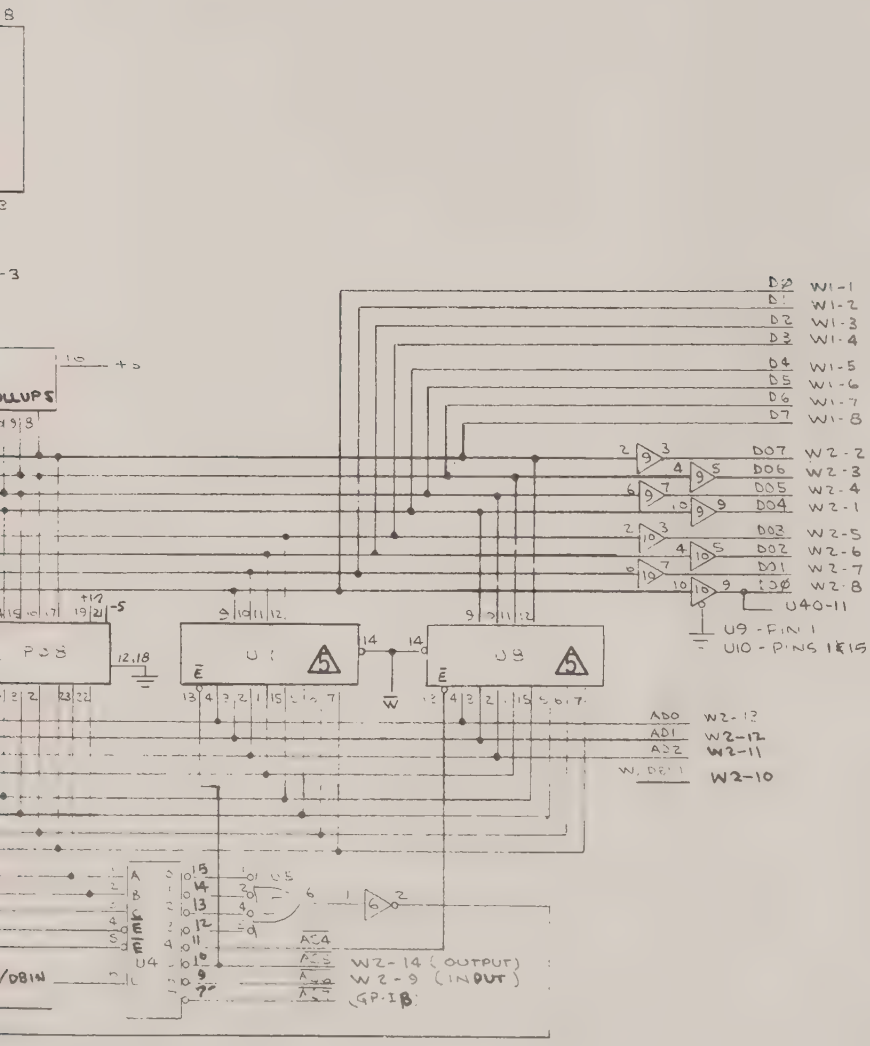
Drawings, Diagrams, Wire Lists

DRAWINGS, DIAGRAMS, WIRE LISTS

This section includes the following figures:

7-1 Model 4880 Main Board Logic Diagram
7-2 Model 4880 Memory Expansion Module Logic Diagram
7-3 Model 4884/5A Serial I/O Logic Diagram

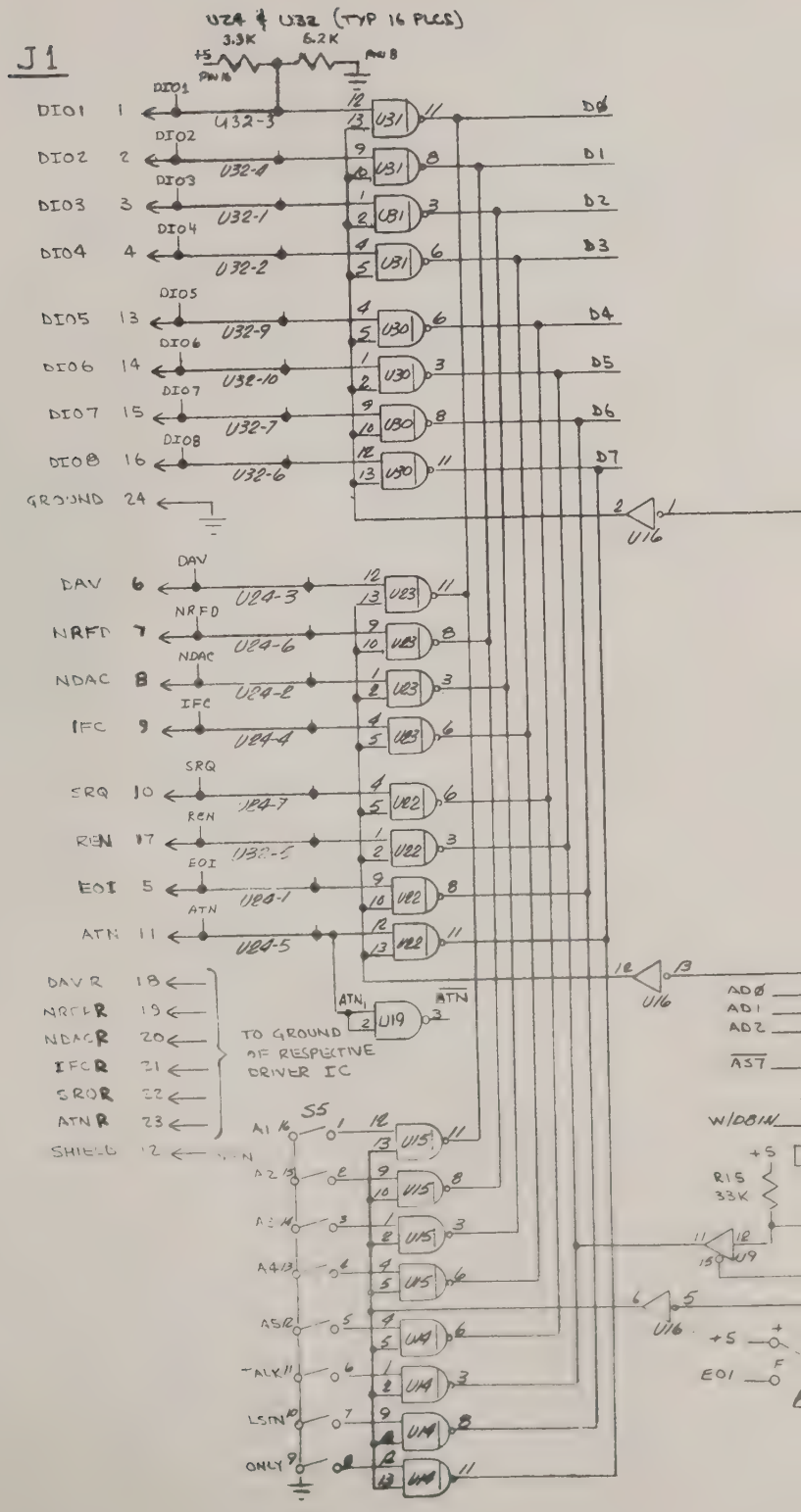

RESET
S2
+5
R9
33K
CR12
IN4001
24PF
C21
R21 2.2K
R22 2.2K
Y1
14.745MHz
24PF
C22
R17
160Ω
C19
.01uf
C15
2uf
R23
100K
1FC
(SHZ)
R10
33K
U11
U12
U18
U40
J51
R19
33K
W2-16
10UF
C16
10UF
C17
R11
330Ω
R12
330Ω
U1
ØZ
Ø1
SYNC
RST
DT
HOLD
GRD
RDY
+12
-5
U2 PØØ
DBIN
INT
U13
U40-5
33K
ATN
DR



NOTES:

5. 4884 & 4885's - U7 AND U8 REPLACED BY MEMORY EXPANSION MODULE
4. 4885 ONLY
3. C6,C8 NOT USED
2. JUMPER E TO + FOR USE, WITH TEKTRONIX 4051 (STD)
   JUMPER E TO F TO ENABLE PARALLEL POLL LOGIC
1. JUMPER I TO A FOR MODELS 4881 THRU 4883
   JUMPER I TO DR FOR MODEL 4884

Figure 7-1 Model 4884 Main Board Logic Diagram


J1
U24 & U32 (TYP 16 PLCS)
3.3K
6.2K
+5
DIO1
DIO2
DIO3
DIO4
DIO5
DIO6
DIO7
DIO8
GROUND
DAV
NRFD
NDAC
IFC
SRQ
REN
EOI
ATN
DAVR
NRFDR
NDACR
IFCR
SRQR
ATNR
SHIELD
TO GROUND AT RESPECTIVE DRIVER IC
S5
A1
A2
A3
A4
A5
A6
ALK
LSTN
ONLY
D0
D1
D2
D3
D4
D5
D6
D7
U16
U19
U9
R15
33K
W/DBIN
AD0
AD1
AD2
AST
EOI

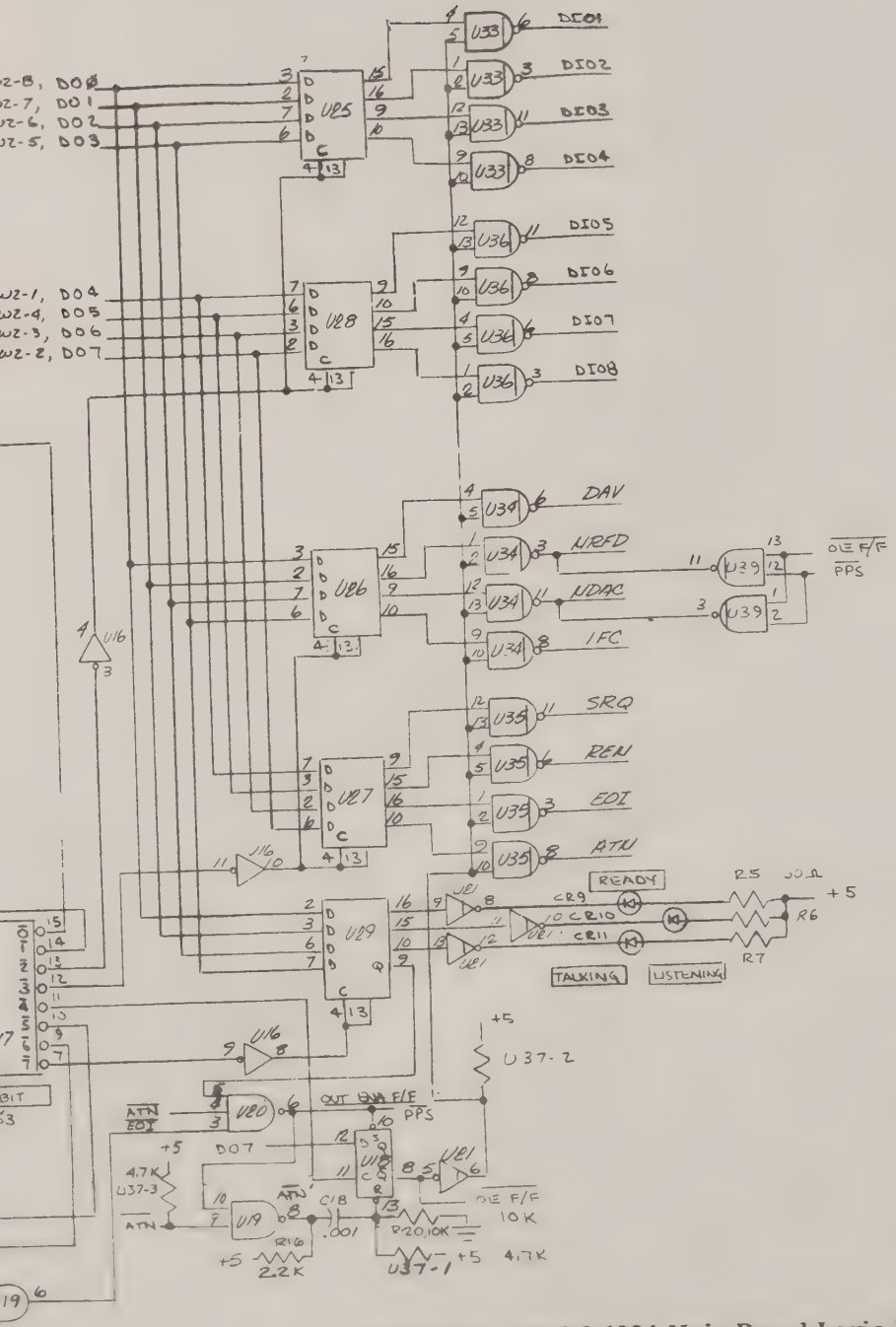
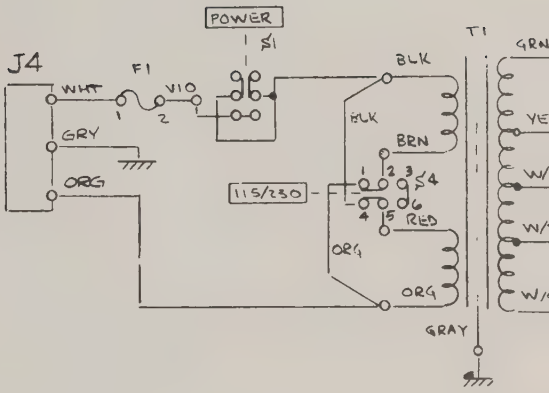


Figure 7-1 Model 4884 Main Board Logic Diagram (Continued)


POWER
S1
T1
J4
WHT
F1
V10
GRY
ORG
BLK
BLK
BRN
115/230
RED
ORG
ORG
GRAY
GRN
YE
W/
W/
W/

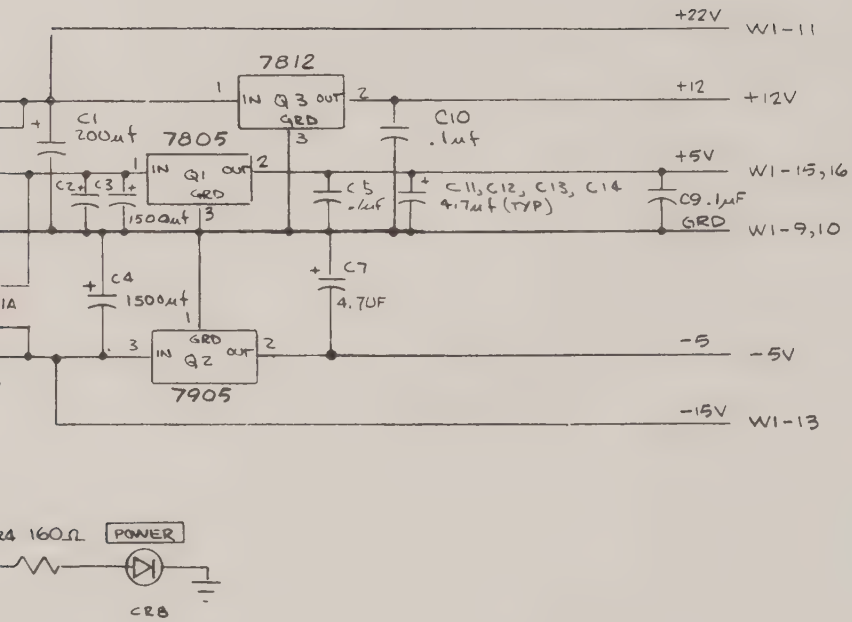
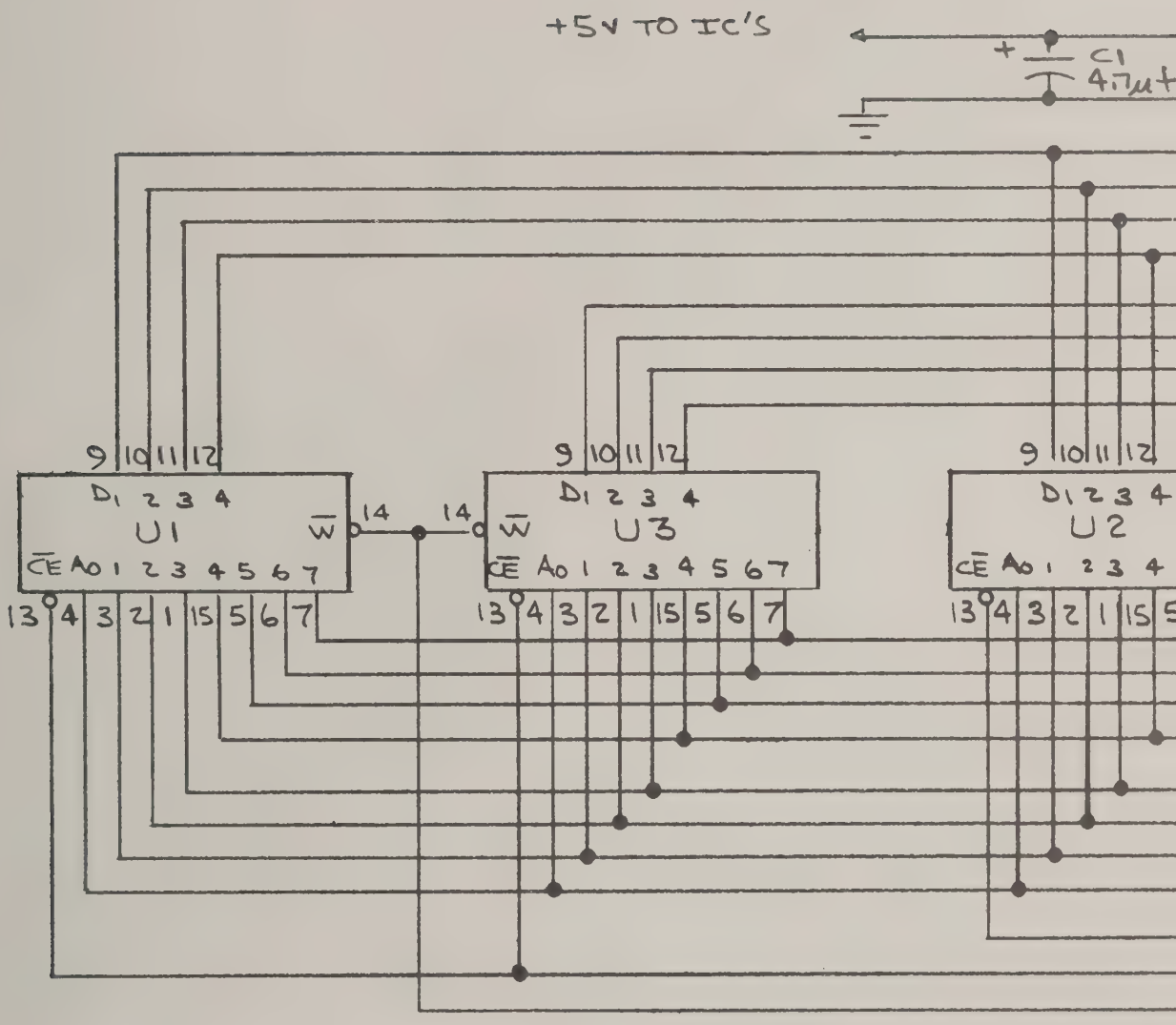


Figure 7-1 Model 4884 Main Board Logic Diagram (Continued)


+5V TO IC'S
+
C1
47µf
U1
U3
U2
D1 2 3 4
CE A0 1 2 3 4 5 6 7
W
9 10 11 12
13 4 3 2 1 15 5 6 7
14
14

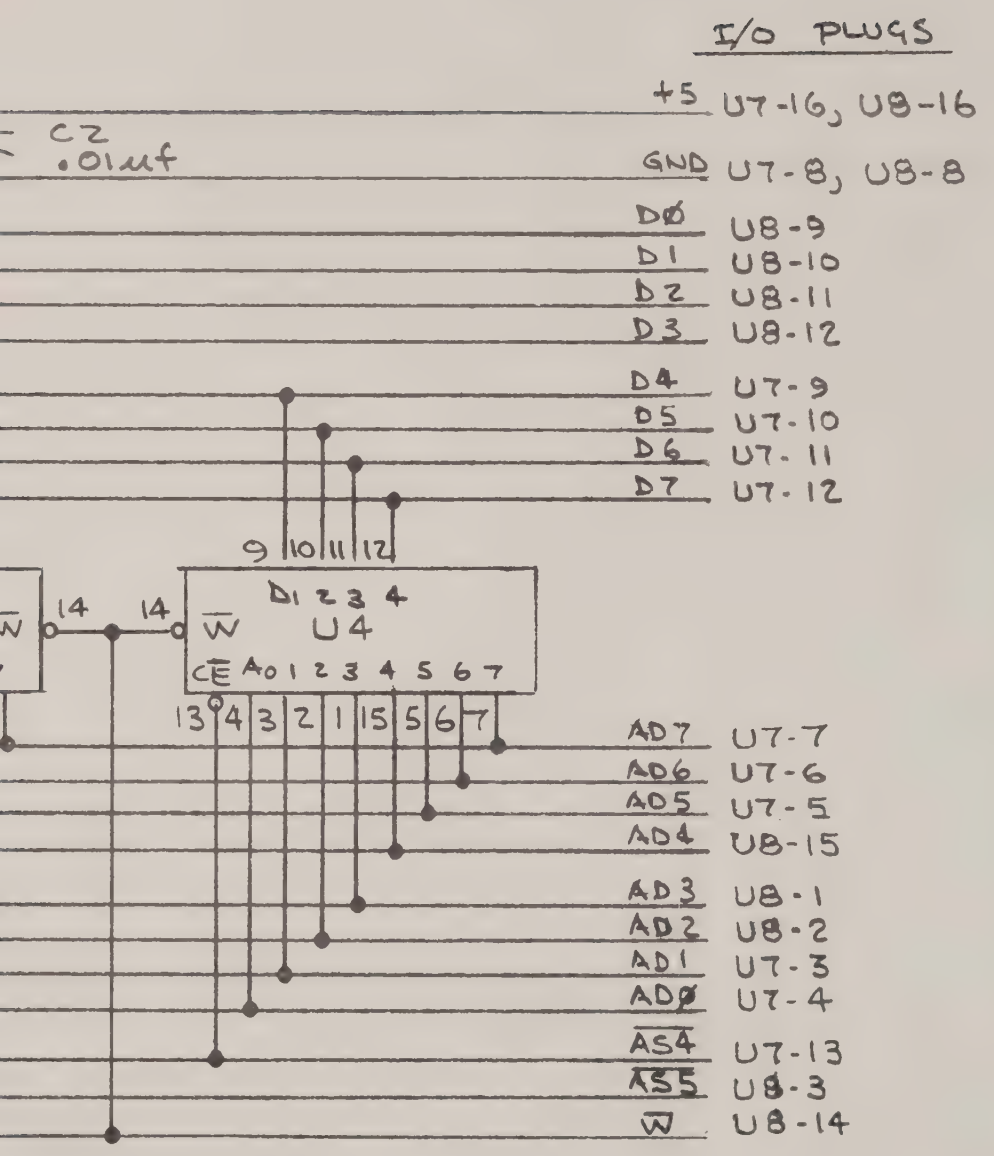
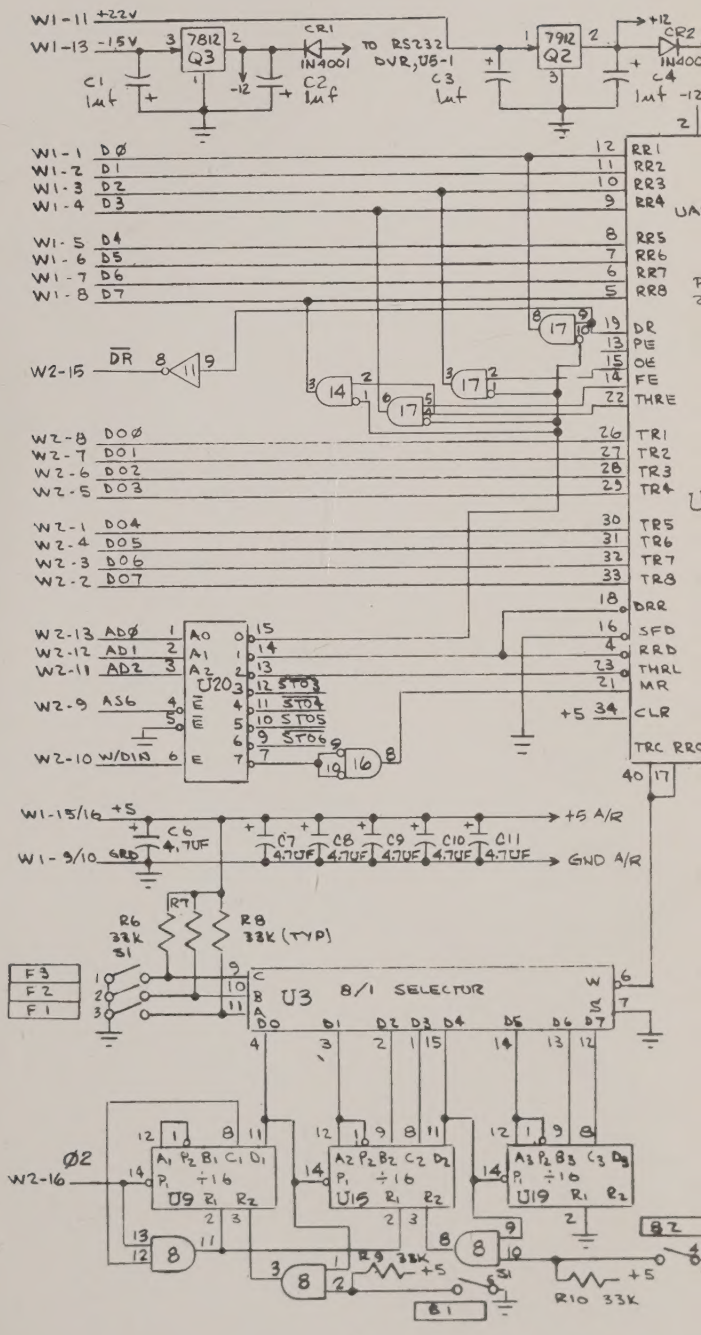


Figure 7-2 Model 4880 Memory Expansion Module Logic Diagram


W1-11 +22V
W1-13 -15V
7812 Q3
CR1 IN4001
TO RS232 DVR, US-1
7912 Q2
CR2 IN4001
C1 1uf
C2 1uf
C3 1uf
C4 1uf
W1-1 D0
W1-2 D1
W1-3 D2
W1-4 D3
W1-5 D4
W1-6 D5
W1-7 D6
W1-8 D7
RR1
RR2
RR3
RR4
RR5
RR6
RR7
RR8
W2-15 DR
DR
PE
OE
FE
THRE
W2-8 D00
W2-7 D01
W2-6 D02
W2-5 D03
W2-1 D04
W2-4 D05
W2-3 D06
W2-2 D07
TR1
TR2
TR3
TR4
TR5
TR6
TR7
TR8
W2-13 AD0
W2-12 AD1
W2-11 AD2
W2-9 AS6
W2-10 W/DIN
U20
STO3
STO4
STO5
STO6
DRR
SFD
RRD
THRL
MR
+5
CLR
TRC RRC
W1-15/16 +5
W1-9/10 GRD
C6 4.7UF
C7 4.7UF
C8 4.7UF
C9 4.7UF
C10 4.7UF
C11 4.7UF
+5 A/R
GND A/R
R7
R6 33K S1
R8 33K (TYP)
F3
F2
F1
U3 8/1 SELECTOR
D0 D1 D2 D3 D4 D5 D6 D7
W2-16 Ø2
U9 R1 R2
U15 R1 R2
U19 R1 R2
R9 33K
R10 33K
+5
S1
B1
B2

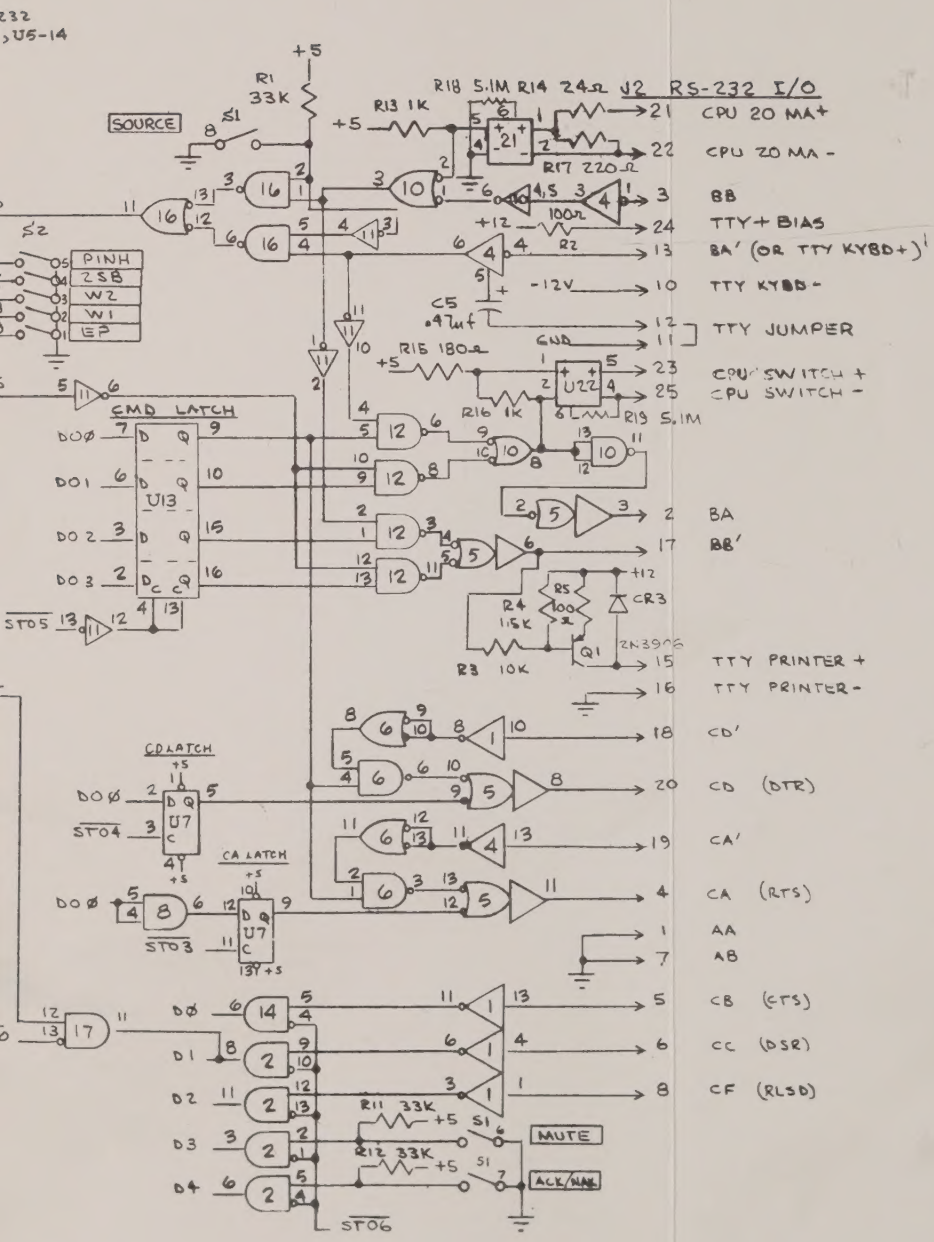


Figure 7-3 Model 4884 Serial I/O Card Logic Diagram

MP MASTER
MA34628